Europäisches Patentamt
European Patent Office
Office européen des brevets

(19)

(11) Publication number: **0 288 141 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 88301876.4

(22) Date of filing: 03.03.88

(51) Int. Cl.4: F27B 15/00 , F27B 9/16

(30) Priority: 23.03.87 GB 8706852

(43) Date of publication of application: 26.10.88 Bulletin 88/43

(84) Designated Contracting States: AT BE CH DE ES FR GB GR IT LI LU NL SE

(71) Applicant: TORFTECH LIMITED
Mortimer Hill Mortimer
Reading Berkshire, BG7 3PG(GB)

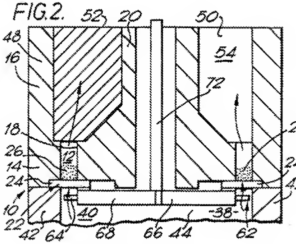
(72) Inventor: Dodson, Christopher Edward
Mortimer Hill Mortimer
Reading Berkshire, BG7 3PG(GB)

(74) Representative: Abbie, Andrew Kenneth et al
R.G.C. Jenkins & Co. 26 Caxton Street
London SW1H 0RJ(GB)

(54) Treating fluid matter.

(57) A bed 26 of particulate material is moved in a band continuously along an annular path by passing fluid media having both circumferential and vertical components through the bed along that path. The fluid media comprises combustion gases which are passed through the bed along a portion of the path for heating the particulate material as it passes therethrough and fluid matter to be heated which passes through the bed along another portion of its path such that the fluid matter is heated as it passes through the particulate material which has been heated by the combustion gases.

FIG. 2.



EP 0 288 141 A2

TREATING FLUID MATTER

This invention relates to treating fluid matter and particularly, but not exclusively, to heating gaseous matter.

Our specification EP-B-68853 discloses moving a bed of particulate material in a band continuously along an annular path by passing a fluid medium provided as combustion gases having both circumferential and vertical components through the bed along its path. The combustion gases heat the particulate material as they pass through the bed, and matter, which may be other particulate material, is added to the bed so as to mix with the heated particulate matter and be heated thereby.

An object of the present invention is to utilise a bed of particulate material which moves in a band along an annular path as aforesaid for treating fluid matter.

The invention includes a method of treating fluid matter, comprising moving a bed of particulate material in a band continously along an annular path by passing fluid media having both circumferential and vertical components through said bed along said path, said fluid media comprising fluid which is passed through said bed along a portion of said path along which the particulate material is treated and fluid matter to be treated which passes through said bed along another portion of said path such that the fluid matter is treated as it passes through the particulate material which has been treated during its passage through said first mentioned portion.

The fluid media may comprise fluid and fluid matter to be treated which pass through said bed along alternately disposed portions of said annular path, the particulate material being treated in said portions in which fluid is passed through the bed.

The fluid media may comprise other fluid which is passed through said bed along other portions of said annular path.

The particulate material may be treated by said fluid as said fluid passes through the bed. Alternatively the fluid may simply serve to move the bed along the or each portion of the path through which it is passed, the particulate material being otherwise treated during its passage along that or those portions of the path.

The fluid may comprise combustion gases which are used to heat the particulate material as they pass through the bed such that the fluid matter is heated as it passes through the particulate material which has been heated by the combustion gases.

Thus, the invention includes a method of heating fluid matter, comprising moving a bed of particulate material in a band continuously along an annular path by passing fluid media having both circumferential and vertical components through said bed along said path, said fluid media comprising combustion gases which are passed through said bed along a portion of said path for heating the particulate material as it passes therethrough and fluid matter to be heated which passes through said bed along another portion of said path such that the fluid matter is heated as it passes through the particulate material which has been heated by said combustion gases.

The fluid media may comprise combustion gases and fluid matter to be heated which pass through said bed along alternately disposed portions of said annular path.

The fluid media may comprise other fluid which is passed through the bed along other portions of the annular path. For example the fluid media may comprise a purging gas which is passed through the bed along a portion of the path thereof between a portion along which said combustion gases are passed and a portion along which said fluid matter to be heated is passed.

It will be appreciated that in the method as aforesaid the combustion gases do not pass through the bed along all of its annular path. However, it is to be understood that the method may comprise initially passing combustion gases through said bed along all, or substantially all, of said annular path in order to bring the bed up to a desired temperature as quickly as possible.

Preferably, the flow of fluid matter which has been heated by passing through said bed is maintained separate from the rest of the fluid media after it has passed through said bed.

As mentioned previously the method is particularly applicable to heating gaseous matter and for example may advantageously be used for the pyrolysis of gas.

The invention also provides apparatus for treating fluid matter comprising a chamber for a bed of particulate material, the base of which chamber is provided with an annular fluid media inlet means, means for imparting vertical and circumferential components to the flow of fluid media through said inlet means for moving a bed of particulate material in said chamber in use in a band along an annular path in said chamber as said fluid media passes through said particulate material, first passage means for supplying fluid to said annular fluid media inlet means along a first portion thereof, second passage means for supplying fluid matter to be treated to said annular fluid media inlet means along a second portion thereof, and outlet means for said fluid media after it has passed

through said bed comprising separate outlet means for said fluid and said fluid matter.

The apparatus may comprise a plurality of first passage means for supplying said fluid to said annular fluid media inlet means along respective first portions thereof, a plurality of second passage means for supplying fluid matter to be treated to said annular fluid media inlet means along respective second portions thereof which second portions are arranged alternately with said first portions, said outlet means comprising separate outlet means for said fluid and fluid matter from each said passage means. The or each first passsage means may be arranged to supply combustion gases to said inlet means along the or each first portion thereof.

The apparatus may also include respective third passage means for supplying purging gas to said annular fluid media inlet means along a respective third portion thereof between the or each first portion and the or each second portion downstream thereof.

The or each first passage means may have fuel supply means located therein and disposed beneath the or each first portion of the fluid media inlet means along the extent thereof. Additionally, separately controllable fuel supply means may be located beneath the remainder of the fluid annular media inlet means along the extent thereof.

In one particular embodiment of the invention, described hereinafter, the chamber is bounded externally by an axially intermediate portion of a tubular wall, the passage means being defined at least partially by lower partitioning extending inwardly of the tubular wall beneath the annular fluid media inlet means and the separate outlet means being defined at least partially by upper partitioning extending inwardly of the tubular wall above and spaced from the annular fluid media inlet means.

The upper partitioning may be located angularly offset with respect to the lower partitioning in the sense in which the bed is moved along the annular path in use.

The means for imparting vertical and circumferential components to the flow of fluid media through the inlet means may comprise an annular array of fixed inclined vanes. These vanes may be arranged in overlapping relationship.

In order that the invention may be well understood, an embodiment thereof, which is given by way of example only, will now be described with reference to the accompanying drawing in which:

Figure 1 is a schematic top plan view of an apparatus for treating fluid matter; and

Figure 2 is an axial cross-section view of the same apparatus taken along the line II-II of Figure 1.

The apparatus 10 shown in the drawings includes a chamber 12 which is bounded externally by an axially intermediate portion 14 of a tubular wall 16 of the apparatus. In the illustrated apparatus, the chamber 12 is annular, being bounded internally by an annular wall 18 of a central structure 20 of the apparatus. The base of the chamber is provided with an annular fluid media inlet 22 which is spanned by an annular array of fixed inclined vanes 24. For simplicity, only a portion of the array of vanes is illustrated in Figure 1. However, it is to be understood that the array extends completely around the inlet 22. The vanes 24, which in the embodiment are arranged in overlapping relationship, are inclined in order to impart vertical and circumferential components to flow of fluid media through the annular inlet 22 to move a bed of particulate material disposed in the chamber 12 in use of the apparatus and indicated at 26 in Figure 2 in a compact band continuously along an annular path in the chamber 12 as the fluid media passes through the particulate material. In the embodiment, the vanes are arranged so that bed of particulate material moves along this annular path in the sense indicated by arrows 28 in Figure 1.

The illustrated apparatus is utilised for treating fluid matter by heat and the fluid media which passes through the particulate material comprise combustion gases which are supplied to the annular inlet 22 along a first portion 30 thereof extending over 180° between locations 32 and 34indicated in Figure 1 and fluid matter to be heated in the apparatus which is supplied along a second portion 36 of the annular inlet 22 extending through 180° between locations 34 and 32.

It will be appreciated that the combustion gases heat the particulate material as they pass through the bed along a first portion of its annular path and the fluid matter is heated as it passes through the particulate material, which has been previously heated by the combustion gases, along a second portion of the bed's annular path.

The apparatus includes respective passages 38,40 for supplying the combustion gases and fluid matter to the inlet portions 30 and 36. These passages are bounded by an annular portion 42 of the tubular wall 16 beneath the inlet 22 and by partitioning 44,46 extending inwardly of the tubular wall portion 42 to divide the space within the tubular wall beneath the inlet 22 into passage 38 extending beneath portion 30 of the inlet 22 and passage 40 extending beneath portions 36 thereof.

The apparatus also includes respective outlet passages for the combustion gases and fluid matter after their passage through the bed of particulate material 26. These passages are bounded by an annular portion 48 of the tubular wall 16 above the portion 14 thereof which bounds the chamber 12 and by partitioning 50, 52 extending

inwardly of the tubular wall from the portion 16 thereof to the central structure 20 of the apparatus. The partitioning 50, 52 is spaced above the annular inlet 22 so as not to interfere with the progress of the bed along its annular path in the chamber 12. The outlet passages for combustion gases which have passed through portion 30 of the inlet 22 is defined between surfaces 54, 56 of the partitioning 50, 52 and the outlet passage for fluid matter which has passed through the portion 36 of the inlet 22 is defined between surfaces 58 and 60 of the partitioning 50, 52.

It will be noted that the upper partitioning 50, 52 for the outlet passages is located angularly offset with respect to the lower partitioning 44, 46 in the sense in which the bed is moved along the annular path. This is to ensure that combustion gases passing through portion 30 of the inlet 22 adjacent partitioning 34 pass through the outlet passage for the combustion gases after it has travelled through the chamber 12 with a circumferential component in the sense indicated by arrows 28.

The passage 38 extending beneath portion 30 of the inlet 22 has fuel supply means, which are generally indicated at 62 in Figure 1, located therein and disposed beneath the portion 30 of the inlet 22 along the extent of portion 30 for supplying fuel for combustion with air passing through passages 38 to provide combustion gases to portion 30. Separately controllable fuel supply means, which are generally indicated at 64 in Figure 1, are located beneath the remainder of the inlet 22 along the extent thereof. That is, in the illustrated embodiment, they are located in passage 40 beneath portion 36 of the inlet 22 along the extent of portion 36. The supply means 64 are arranged for supplying fuel for combustion with air passing through passage 40 during start-up of the apparatus to provide combustion gases to portion 36 of the inlet. In this way, during start-up combustion gases can be passed through the bed 26 along all of its annular path to ensure that the bed can be brought up to a desired operating temperature as quickly as possible. It is to be understood that after the bed has been brought up to its desired temperature, the supply of fuel through fuel supply means 64 would be terminated and the fluid matter to be heated in the apparatus would be passed through passage 40 to portion 36 of the inlet 22 instead of air for combustion. The fuel supply means 62 and 64 may take any conventional form and are illustrated in the embodiment as fuel injectors disposed beneath the respective portions 30, 36 of the inlet 22 which are fed by manifolds 66 and 68 respectively. These manifolds are connected to a supply of fuel by respective pipes 70, 72 extending through the central structure 20 of the apparatus. As will be appreciated each pipe 70, 72 is provided with a respective flow control valve (not illustrated) so that the flow through the pipes can be separately controlled.

It is to be understood that whilst in the illustrated embodiment, the portion 30 of the inlet 22 through which the combustion gases are passed and the portion 36 thereof through which the fluid matter to be heated is passed are each 180°, their angular extent may be varied. Further the embodiment may be modified so that combustion gases and fluid matter to be heated pass through the bed along alternately disposed portions of its annular path. For this purpose, the apparatus may be modified to include a plurality of first passages for supplying combustion gases to the inlet 22 along respective first portions of the inlet and a plurality of second passages for supplying fluid matter to be heated to the inlet 22 along respective second portions thereof, the second portions being arranged alternately with the first portions. This may be achieved by providing additional partitioning beneath the inlet 22 similar to partitioning 40, 46 but angularly spaced therefrom. In this case separate outlets for the combustion gases and fluid matter from each of the passages beneath the inlet 22 are provided, for example by providing additional partitioning above the inlet 22 similar to partitioning 50, 52 but angularly spaced therefrom. In such a modified apparatus fuel supply means would be provided in the first passages and separately controllable fuel supply means may be provided in the second passages for start-up.

It is also envisaged that the embodiment may be modified such that another fluid, for example a purging gas can be passed through the bed along a portion of its path between that portion thereof along which the combustion gases are passed and that portion along which the fluid matter to be heated is passed. For example, the illustrated embodiment may be modified to incorporate additional partitioning 74, 76 indicated by chain-dotted lines in Figure 1 upstream of the partitioning 44 and 50 respectively to define with the partitioning 44 and 50 a passage beneath the inlet 22 for supplying purging gas to the inlet along the portion thereof between partitioning 74 and 44 and a passage between partitioning 76 and 50 above the inlet for the outlet of the purging gas.

Whilst the embodiment has been described in relation to heating fluid matter, it is to be understood that the invention is also applicable to treating fluid matter in other ways, in which case fluid other than combustion gases could be supplied to the portion or portions of the inlet 22 to which combustion gases are supplied in the embodiment with the particulate material being treated either by that other fluid or by other means as it is moved by

that other fluid along a portion or portions of its annular path, the fluid matter passing through the thus treated particulate matter along another portion or other portions of the path being treated thereby. One particular other application is the cleaning of gaseous matter by contact with material coated on the particulate material.

Claims

1. A method of treating fluid matter, comprising moving a bed of particulate material in a band continously along an annular path by passing fluid media having both circumferential and vertical components through said bed along said path, said fluid media comprising fluid which is passed through said bed along a portion of said path along which the particulate material is treated and fluid matter to be treated which passes through said bed along another portion of said path such that the fluid matter is treated as it passes through the particulate material which has been treated during its passage through said first mentioned portion.

2. A method as claimed in claim 1, wherein said fluid media comprises fluid and fluid matter to be treated which pass through said bed along alternately disposed portions of said annular path, the particulate material being treated in said portions in which fluid is passed through the bed.

3. A method as claimed in claim 1 or 2, wherein said fluid media comprises other fluid which is passed through said bed along other portions of said annular path.

4. A method as claimed in claim 1, 2 or 3, wherein said particulate material is treated by said fluid as said fluid passes through the bed.

5. A method of heating fluid matter, comprising moving a bed of particulate material in a toroidal band continuously along an annular path by passing fluid media having both circumferential and vertical components through said bed along said path, said fluid media comprising combustion gases which are passed through said bed along a portion of said path for heating the particulate material as it passes therethrough and fluid matter to be heated which passes through said bed along another portion of said path such that the fluid matter is heated as it passes through the particulate material which has been heated by said combustion gases.

6. A method as claimed in claim 5, wherein said fluid media comprises combustion gases and fluid matter to be heated which pass through said bed along alternately disposed portions of said annular path.

7. A method as claimed in claim 5 or 6, wherein said fluid media comprises other fluid which is passed through said bed along other portions of said annular path.

8. A method as claimed in claim 5 or 6, wherein said fluid media comprises a purging gas which is passed through said bed along a portion of the path thereof between a portion along which said combustion gases are passed and a portion along which said fluid matter to be heated is passed.

9. A method as claimed in any one of claims 5 to 8, comprising initially passing combustion gases through said bed along all, or substantially all, of said annular path.

10. A method as claimed in any one of the preceding claims including maintaining said flow of fluid matter separate from the rest of said fluid media after it has passed through said bed.

11. A method as claimed in any one of the preceding claims, wherein said fluid matter to be heated comprises gaseous matter.

12. Apparatus for treating fluid matter, comprising a chamber for a bed of particulate material, the base of which chamber is provided with an annular fluid media inlet means, means for imparting vertical and circcumferential components to the flow of fluid media through said inlet means for moving a bed of particulate material in said chamber in use in a band along an annular path in said chamber as said fluid media passes through said particulate material, first passage means for supplying fluid to said annular fluid media inlet means along a first portion thereof, second passage means for supplying fluid matter to be treated to said annular fluid media inlet means along a second portion thereof, and outlet means for said fluid media after it has passed through said bed comprising separate outlet means for said fluid and said fluid matter.

13. Apparatus as claimed in claim 12, comprising a plurality of first passage means for supplying said fluid to said annular fluid media inlet means along respective first portions thereof, a plurality of second passage means for supplying fluid matter to be treated to said annular fluid media inlet means along respective second portions thereof which second portions are arranged alternately with said first portions, said outlet means comprising separate outlet means for said fluid and fluid matter from each said passage means.

14. Apparatus as claimed in claim 12 or 13, wherein the or each first passage means is arranged to supply combustion gases to said inlet means along the or each first portion thereof.

15. Apparatus as claimed in claim 14, including respective third passage means for supplying purging gas to said annular fluid media inlet means

along a respective third portion thereof between the or each first portion and the or each second portion downstream thereof.

16. Apparatus as claimed in claim 14 or 15, wherein the or each first passage means has fuel supply means located therein and disposed beneath the or each first portion of the fluid media inlet means along the extent thereof.

17. Apparatus as claimed in claim 16, wherein separately controllable fuel supply means are located beneath the remainder of said annular fluid media inlet means along the extent thereof.

18. Apparatus as claimed in any one of claims 12 to 17, wherein said chamber is bounded externally by an axially intermediate portion of a tubular wall, said passage means being defined at least partially by lower partitioning extending inwardly of said tubular wall beneath said annular fluid media inlet means and said separate outlet means being defined at least partially by upper partitioning extending inwardly of said tubular wall above and spaced from said annular fluid media inlet means.

19. Apparatus as claimed in claim 18, wherein the upper partitioning is located angularly offset with respect to said lower partitioning in the sense in which the bed is moved along the annular path in use.

20. Apparatus as claimed in any one of claims 12 to 19, wherein said means for imparting vertical and circumferential components to the flow of fluid media through said inlet means comprises an annular array of fixed inclined vanes.

21. Apparatus as claimed in claim 20, wherein said vanes are arranged in overlapping relationship.

FIG.1.

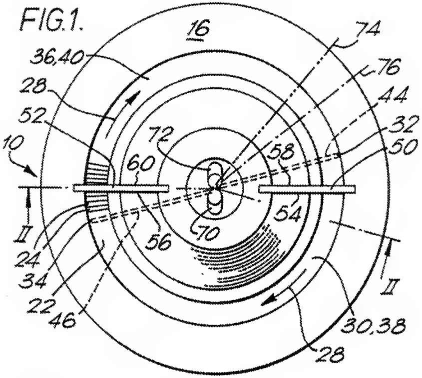
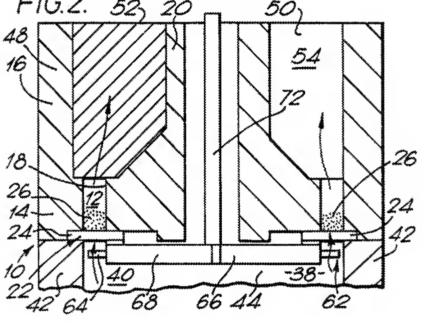

16
74
36,40
76
28
44
52
32
72
58
50
10
60
54
II
70
56
24
34
II
22
46
30,38
28

FIG.2.


52
20
50
48
54
16
72
18
26
26
12
14
24
24
42
10
40
38
42
22
42
64
68
66
44
62

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : 0 672 353 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number : 95650006.0

(22) Date of filing : 09.03.95

(51) Int. Cl.[6] : A23L 1/168, A23L 1/10, A23L 1/182

(30) Priority : 15.03.94 AU PM4474/94

(43) Date of publication of application : 20.09.95 Bulletin 95/38

(84) Designated Contracting States : DE ES FR GB IT NL

(71) Applicant : BYRON AGRICULTURAL COMPANY PTY LTD
19A Boundary Street,
Rushcutters Bay
New South Wales 2011 (AU)

(72) Inventor : Lewis, Victor Marcus
No. 3 Shellcove Road
Neutral Bay, New South Wales 2089 (AU)
Inventor : Lewis, David Adrian
No. 273 Woolooware Road
Burraneer, New South Wales 2230 (AU)

(74) Representative : Duffy, Assumpta Dympna et al
F. R. Kelly & Co.,
27 Clyde Road,
Ballsbridge
Dublin 4 (IE)

(54) Improved grain product.

(57) The present invention relates to a whole grain preferably wheat product and a process of preparing same, said product being prepared by the steps of increasing the moisture content of the grain to about 20 - 45% ; heating the hydrated grain at temperatures ranging between 100-130°C for 7 - 50 minutes ; dehydrating the grain to a moisture content of about 18 - 30% ; compressing the grains following a short tempering period ; and rapidly drying the grains following compression.

EP 0 672 353 A1

Jouve, 18, rue Saint-Denis, 75001 PARIS

The major source of starchy carbohydrate foods on a global basis is derived from grains (Gramineae). While there are other important starchy carbohydrate sources, such as potatoes, cassava, sweet potatoes etc., grains are pre-eminent in providing starchy carbohydrate energy for the world's population. One reason for this is that grains are harvested in a naturally dry state and hence are relatively non-perishable. By contrast potatoes, cassava and sweet potatoes, for example, are harvested at an elevated moisture content and because of this they have a shorter storage life in their harvested state.

Of the major food grains, wheat is produced in the largest tonnage. Rice and corn are produced in very large quantities, with barley, rye, sorghum, oats, millets etc being produced in substantial but lesser amounts. Of those grains which are used directly for food for human consumption (as distinct from grains which are used for animal feeds) rice is the only major grain which is cooked (mostly as white rice and to some extent as brown rice) by the ultimate consumer predominantly in a whole-grain form. No doubt the reason for this is that rice may be cooked, for example, by boiling in water in a period of time which is conveniently short, for example 15-20 minutes. Other major grains such as wheat, corn, rye, sorghum, barley, are very slow (and hence inconvenient) to cook. As a consequence the major usage of these grains as food is in the form of flours, flakes or meals which are more conveniently consumed in various forms such as bakery products, porridge, pastas, etc.

There exists however, especially in the Middle East, a traditional food based on whole-grain wheat whereby the grain is consumed as a whole or cracked grain in the form of Bulgur (or Burghul). Bulgur is really a parboiled wheat product (analogous to parboiled rice). However, since whole-grain bulgur is fairly slow cooking, (45-60 minutes of cooking) the individual grains are usually cracked into small pieces so that the consumer can cook the bulgur in a more conveniently shorter time. Even so cracked bulgur requires cooking for 10-15 minutes then gently steaming for a similar period.

The technical and patent literature describes a number of methods for producing bulgur, by both traditional and by more modern industrial methods.

U.S. Patents 2,884,327 and 3,778,521 (Fisher et al) describe a process for the continuous production of bulgur.

U.S. Patent 3,526,511 (Rockland et al) describes a quick-cooking whole-grain wheat food produced by impregnating the grains with a solution of salt, alkaline salts and a chelating salt, the grains then being dried.

U.S. Patent 2,930,697 (Miller) produces a quick cooking wheat grain product by soaking the grains to soften them, partially flattening the grain, further hydrating and cooking the grain to cause substantial swelling and to achieve substantial and uniform gelatinisation then drying the swollen grain in rapidly moving air so that the grain sets and dries in its enlarged condition.

U.S. Patent 3,457,084 (Weiss) produces a water-saturated wheat grain which is gelatinised by radio frequency energy.

U.S. Patent 3,190,754 (Matthews) steeps the wheat in caustic soda and an ammonium salt, then elutes the alkaline materials, neutralises it and dries it.

U.S. Patent 3,264,113 (Barta et al) uses hot alkali to strip the bran layer from whole grains of wheat, typically pre-heated by steam or water, followed by vigorous agitation in cold water to remove the alkalinised bran layer, neutralisation and drying. The final product is light coloured and cooks in 15 to 30 minutes.

U.S. Patent 3,162,535 (Ferrel) uses previously fully parboiled and debranned wheat which is then heated in rapidly moving air preferably at 260-316°C to achieve a puffing effect. The puffed wheat product is prepared for eating by adding boiling water and allowing the food to stand for about 5 minutes.

U.S. Patent 3,228,771 (Copley et al) describes a more elaborate method of bran removal from raw wheat grain (i.e., not parboiled) with an associated bleaching step, followed by hot air puffing. The puffed products cooked in 10-20 minutes as compared to the 45-60 minutes required to cook wheat which has not been puffed.

The present invention has as its primary object the production of whole-grain (preferably wheat) quick-cooking grain which may be cooked in a few minutes, providing thereby a convenient carbohydrate food which may be used as an alternative to potatoes, pasta, rice or other forms of cooked carbohydrate as well as in other ways.

A further object is the production of a grain product in which all the bran germ and other components having high nutritional value may be left substantially present in the final product.

A yet further object is to produce a grain product which does not have a strong parboiled or toasted flavour when finally cooked for eating.

A further object is to produce a grain product which does not necessarily require cooking and may be consumed after brief soaking in water or even in its dry form as a crunchy cereal-type food.

It is also an object of the invention that there should be minimum or no use of chemical additives such as alkalis, salts, chelating agents and the like in processing the grains, since there is a negative reaction by many consumers towards the use of chemicals in the processing of basic foods.

A still further object is to produce a whole-grain quick-cooking product by a process during which the amount of absorption of moisture by the grain is minimised thereby achieving maximum economy. Other

objects and advantages will be apparent from the ensuing detailed description of a grain product (preferably wheat) and its preparation.

The invention discloses a process for preparing an edible food product from wheat and other whole grains wherein the processed product is recognisable as an integral natural grain, except where the grain has been subdivided after completion of the process, said whole grain product being quick-cooking, or quickly rehydratable and then suitable for consumption either before or after cooking and rehydration, the process comprising the steps of:

(a) increasing the water content of the grain to a predetermined level, preferably by soaking in water until the moisture content is about 20%-45 %
(b) heating the hydrated grain at temperatures ranging between 100-130°C for 7 - 50 minutes, preferably by heating in live steam
(c) subjecting the heated grains to partial dehydration to decrease the moisture content to about 18 to 30%
(d) optionally removing a proportion of the outer bran layer
(e) subjecting the processed grain to compression preferably by passing the grains after brief tempering between rollers
(f) rapidly drying the grains either immediately after compression or after the compressed grains have been further dried to a moisture content of about 12%. The invention also relates to a grain product produced by this process. In accordance with this process a quick-cooking or ready to eat grain product is produced which may be cooked by total absorption of the cooking fluid in about 2 to about 7 minutes depending on the chosen processing details, the grains of the cooked food product being separate, non-cohesive, tender, of attractive colour and flavour and having a very desirable nutritional profile and an appearance resembling a natural integral whole grain in cooked form.

It is also within the scope of this process for the final whole grain product to be reduced in size for example by crushing to produce a whole-grain cous-cous like product which is capable of rehydration and preparation for eating simply by the addition of water, preferably boiling water without any further heating or cooking.

While the process is applicable to various types of grains, it is especially suitable for use with wheat of various types such as red and white high protein wheats, medium and soft wheats, durum wheats as well as other Triticum species, barley, triticale, rye, sorghums and millets, maize, oats and the like.

With appropriate variation of the process, an expanded crunchy grain may be produced which finds application as a crunchy ready to eat cereal-type food, in mixtures, bars and the like, in which products the quick-cooking or quick rehydration characteristic is not required in use even though it is an intrinsic characteristic of the food produced by the process.

An embodiment of the invention will be described in relation to wheat.

Wheat which has been fully cleaned and graded is first hydrated by steeping at an elevated temperature which may be typically at 50 to 65°C preferably at 60°C. The advantage of so elevating the temperature is that the time required for moisture absorption is usefully shortened, the risk of microbial activity during steeping is essentially eliminated and no starch gelatinisation will occur. Water absorption is continued until the moisture content increases to about 20% to about 45%, preferably 30% to 35%. Depending on the type of finished product required a final moisture content of about 30% or about 35% may be chosen as will be referred to later. The duration of the steeping process is typically 60 to 90 minutes, the exact time being dependent on the type of grain being processed, the steep temperature and the final moisture content required.

When the grain has absorbed moisture to the desired moisture content it is dewatered or drained of free surface water. Because there has been no removal of any of the bran at this stage there is an advantage that less of the wheat solids are lost into the steep water. While bran may be removed prior to moisture increase, it is preferred that if any bran is to be removed it should be carried out at a later stage of the process as will be described. However, if the bran is of dark colour or of strong flavour, it may be preferred to remove at least part of the bran prior to steeping.

After dewatering or draining as required the grain may require a tempering period to achieve more uniform moisture distribution throughout the grain for example for about 30 minutes. Thereafter the grain is cooked.

To achieve an ultimately quick-cooking wheat food, it is desired that the cooking process be such that only partial gelatinisation of the starch in the grain should be effected. A preferred method of cooking is to use a continuous steam cooker, operating under pressure in which the grain is kept continually slowly moving. If the temperature in the vessel is 121°C (equivalent to 15 p.s.i. gauge) a cook time of about 7 minutes to 14 minutes, preferably about 10 minutes, is required.

Other methods of cooking in steam may be employed, for example, use of a batch steam pressure cooker.

At a moisture content of 30% after steeping, 10 minutes of cooking at 121°C will achieve a suitable degree of partial gelatinisation, whereby the centre of each grain can be seen to be less gelatinised, bordering on ungelatinised. It will be understood to persons skilled in the art that the temperature and duration of

the cook can be inversely varied without particularly varying the degree of gelatinisation.

It is also possible to carry out the partial gelatinisation process in the steep water by increasing its temperature. However it has been found that better control and continuity is achieved by the procedure described above.

The cooked grains exit from the cooker in an extremely separate condition, that is, there is no tendency for the grains to clump together. This is because the bran layer is intact and little or no free starch is available to effect cohesion.

The cooked grains are then partly dehydrated until the moisture content is reduced to 18-30%, preferably 22-24%. This is best carried out by using through-bed continuous dehydration equipment, fluid bed drying or the like. Air temperature for dehydration should be such that the product temperature does not exceed about 100°C. A product temperature during dehydration of about 75°C is quite satisfactory. As soon as the target moisture content is reached the grain may be moved to an abrasive bran removal machine (such as the type of machine widely used for polishing rice) and a degree of bran removal may be effected. Removal of bran at this stage is optional and is not required for the performance of the invention. If partial bran removal is carried out the amount of bran removed would normally be no more than about 5% of the weight of the grain. This will depend on the type of grain being processed and the preference of the processor or the ultimate consumers.

After partial dehydration (and partial bran removal, if this is carried out) the grain is tempered without significant moisture loss for about 15 to 30 minutes. This tempering period allows moisture in the centre of the grains to diffuse outwards to equilibrate with the surface of the grains which is drier as a consequence of the partial dehydration. It is necessary to achieve reasonable moisture uniformity in preparation for the next step of the process.

The tempered grains are then compressed for example by passing them between the rolls of a roller mill set such that the gap between the rolls is about 0.15mm to 0.55mm, preferably about 0.4 to 0.45mm. Compression causes a degree of flattening of the grain, but because the product is somewhat rubbery at this stage the grains bounce back to a thickness which is much greater than the gap through which they pass in the roller mill. The brief tempering period prior to rolling is intended to minimise the tendency of the grains from cracking radially at the periphery. After compression the grains still have the appearance of natural grains, though slightly flattened, the normal shape and the crease being quite identifiable.

After compression the grains are dried in a dehydrating unit in such a way that a degree of expansion occurs. For products which are to be cooked in 5-7 minutes, drying is effected immediately after compression, that is, while the moisture content is at or slightly below that at which compression is carried out. To achieve a desirable result, the grains are exposed to rapidly moving air at about 170°C to about 230°C, preferably at about 200-210°C, the grains being actively fluidised in the rapidly moving air. It requires about 30-40 seconds for the grains to be dried to about 12% moisture, though this time will vary somewhat depending on temperature and on the balance of airspeed and feed rate of the grains into the dehydrating unit.

In order to produce a more rapidly cookable grain suitable for instant snack meals the same general procedure is followed, except that the grain is cooked for a longer period, for example 20 to 25 minutes at 121°C and the compression is increased such that the gap between the rolls is about half of that indicated above (namely 0.4-0.45mm). This product has a bulk density when dried of about 300g/litre while the first described product has a bulk density of about 360-400g/litre. However these bulk density figures will vary depending on the type of grain processed.

Thus by varying the processing parameters as described the ultimate cook time of the grain may be varied from "instant" - requiring about 2 minutes of cooking, to "rapid" - requiring about 5 to 7 minutes of cooking. It will be understood that products can be produced having various different ultimate cooking times by varying certain of the processing parameters as described.

Either of the above products or their variants may be changed from whole-grain form to a reduced size by for example passing the dry whole grain products through crushing equipment to produce a fragmented whole-grain product. The size of the fragments may be varied according to market requirements. Such a fragmented whole grain product can be analogous to a whole-grain cous-cous or pilpil. In the present case, the fragmented whole-grain product may be prepared for eating simply by addition of water, preferably boiling water after which a wait of only 2 to 3 minutes is required to achieve hydration.

To produce an expanded crunchy grain product which does not require cooking the basic process as described above is varied by extending the steep time and hence the moisture content increase to the upper end of the indicated range, for example by steeping for about 90 minutes to achieve a moisture content of about 35%, extending the cook time of the steeped grain to about 35 to 45 minutes at 121°C (or for a shorter time at a higher temperature), compressing the grain to an extent equal to or greater than that indicated for instant and by drying the compressed grain back to about 12% moisture at a moderate temperature below about 100°C preferably about 70°C-80°C followed by toasting of the dried grain in rapidly moving fluidising air at about 190°C to 230°C for about 15 to 30 seconds. As a consequence of these

process modifications, the toasted grains are more expanded, very crispy and of low bulk density, for example 140 to 200g/litre.

Optionally, selected enzymes may be used in the process, for example before or after the compression step. Use of enzymes to enhance expansion of rice and waxy grains has been described in Australian Patents 583817 and 610053 but their use on non-waxy grains such as wheat, barley, rye oats and the like is not disclosed in the prior art.

It will be thus be seen that by varying the heating and temperature ranges depending on the type of product required a whole range of products may be obtained ranging from those requiring extremely short cooking times to those requiring no cooking and in general it has been found that satisfactory products can be produced within these parameters if the heating of the grains is effected at temperatures ranging between 100-130°C for 7 - 50 minutes.

Claims

1. A process of preparing an edible food product from wheat and other whole grains comprising the steps of:
   - increasing the moisture content of the grain to about 20 - 45%;
   - heating the hydrated grain at temperatures ranging between 100-130°C for 7 - 50 minutes;
   - dehydrating the grain to a moisture content of about 18 - 30%;
   - compressing the grains following a short tempering period; and
   - rapidly drying the grains following compression.

2. A process as claimed in claim 1 wherein the moisture content of the grains is increased by soaking in water.

3. A process as claimed in claim 1 or 2 wherein heating of the hydrated grain is effected with live steam.

4. A process as claimed in any preceding claim wherein a portion of the outer bran layer of the grains is removed following the dehydration.

5. A process as claimed in any preceding claim wherein the grains are subject to compression by passing the grains between rollers.

6. A process as claimed in any preceding claim wherein following compression the grains are dried to a moisture content of about 12% in a rapidly moving air stream at a temperature sufficient to achieve expansion of the grains.

7. A process as claimed in any preceding claim wherein the grains following said drying step are sub-divided.

8. A process as claimed in any preceding claim wherein said grains comprise wheats of various types namely red and white high protein wheats, medium and soft wheats, durum wheats and other triticum species, barley, triticale, rye, sorghums, millets, maize and oats.

9. A process as claimed in any preceding claim wherein the compressed grain is dried to a moisture content of about 12% at a temperature below about 100°C and thereafter toasted at about 190°C to about 230°C to achieve an expanded crispy texture.

10. An edible food product prepared from wheat and other whole grains wherein said product is obtainable by the process of any one of claims 1 to 9.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 65 0006

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 275 836 (VICTOR M. LEWIS;DAVID A. LEWIS) * claim 1 *	1-10	A23L1/168 A23L1/10 A23L1/182
X	US-A-4 361 593 (ARTHUR W. BROOKS; ET AL) * claim 1 *	1,2	
A	EP-A-0 393 870 (BYRON AGRICULTURAL COMPANY PTY LTD)	1-10	
A	GB-A-2 210 244 (NABISCO BRANDS INC.)	1-10	
D,A	US-A-2 930 697 (FREDERIC J. MILLER)	1-10	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

A23L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	8 June 1995	Caturla Vicente, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : F27B 15/00, B01J 8/14, 8/32

A1

(11) International Publication Number: WO 89/ 03968

(43) International Publication Date: 5 May 1989 (05.05.89)

(21) International Application Number: PCT/GB88/00887

(22) International Filing Date: 18 October 1988 (18.10.88)

(31) Priority Application Number: 8724873

(32) Priority Date: 23 October 1987 (23.10.87)

(33) Priority Country: GB

(71) Applicant (for all designated States except US): TORF-TECH LIMITED [GB/GB]; Mortimer Hill, Mortimer, Reading, Berkshire BG7 3PG (GB).

(72) Inventor; and
(75) Inventor/Applicant (for US only) : DODSON, Christopher, Edward [GB/GB]; Mortimer Hill, Mortimer, Reading, Berkshire BG7 3PG (GB).

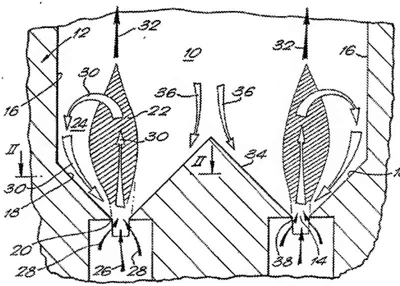
(74) Agents: ABBIE, Andrew, Kenneth et al.; R.G.C. Jenkins & Co., 26 Caxton Street, London SW1R 0RJ (GB).

(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROCESSES IN WHICH MATTER IS SUBJECTED TO FLUID FLOW



(57) Abstract

Apparatus is provided for subjecting matter to fluid flow. The apparatus comprises a chamber (10) having an annular fluid inlet (14) beneath a first annular region (22) in the chamber. A second annular region (24) is contiguous with and disposed outwardly of the region (22) between the region (22) and a circumferential wall (12), which has a slope (18) towards the annular inlet (14). Means shown as an annular array of radially extending slots provided in an annular wall portion (Figure 3) direct fluid through the inlet (14) with vertical and circumferential flow components. In use matter in the chamber is moved in a band continuously along an annular path in the regions (22, 24). The matter is moved vertically and circumferentially whilst in the region (22) by the flow therein, is moved out of this flow into region (24) by circumferential force and is directed back into the region (22) by the slope (18) as indicated by arrows (30). Thus the matter is not continuously subjected to the fluid flow whilst being moved in its annular path in the chamber (10).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BG	Bulgaria
BJ	Benin
BR	Brazil
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

PROCESSES IN WHICH MATTER IS SUBJECTED TO FLUID FLOW

This invention relates to processes in which matter is subjected to fluid flow.

In our specification EP-B-68853 there is disclosed apparatus comprising a chamber having an annular fluid inlet disposed beneath an annular region in the chamber and means for directing fluid flow through the inlet into said annular region with vertical and circumferential flow components for moving a bed of matter in the chamber in a band along an annular path in the annular region as the fluid passes through the bed.

This apparatus may be used for treating the fluid and/or the matter as the fluid passes through the bed of matter. During the treatment of matter and/or fluid in this way the matter is continuously in the flow of fluid as it moves along the annular path. In certain processes such continuous subjection of the matter to the fluid flow can be disadvantageous.

Accordingly, the present invention provides a process in which matter is subjected to fluid flow, comprising providing a flow of fluid in a first annular region having vertical and circumferential flow components, providing a second annular region contiguous with and disposed outwardly of said first region, moving matter in a band continuously around

said regions while circulating matter in said band between said regions such that said matter moves into and out of said flow during movement around said regions.

In a preferred embodiment of the invention to be described hereinafter the matter is moved out of the first annular region by centrifugal force and is returned from said second annular region to said first annular region by a slope in a wall means bounding said second annular region.

The process of the invention is particularly, but not exclusively, applicable where there is a heat transfer between the matter and the fluid flow.

The invention also includes apparatus for subjecting matter to fluid flow, comprising a chamber having an annular fluid inlet means disposed beneath a first annular region in the chamber, the chamber having a second annular region contiguous with and disposed outwardly of the first region between said first region and a circumferential wall means of the chamber, means for directing fluid flow through said inlet into said first annular region with vertical and circumferential flow components, and means for moving matter which has moved out of the flow in said first region into said second region by centrifugal force back into said first region.

The invention also includes apparatus for sub-

jecting matter to fluid flow comprising a chamber having a circumferential wall means extending upwardly and disposed radially outwardly, of an annular fluid inlet means, at least a portion of said wall means having a slope towards said annular fluid inlet means whereby said chamber has a first annular region above said annular fluid inlet means and a second annular region between said first region and said wall means, means for directing fluid through said inlet means into said first annular region with vertical and circumferential flow components such that, in use, matter in said chamber is moved in a band continuously along an annular path in said regions, the matter being moved vertically and circumferentially whilst in said first region by the flow therein, being moved out of said flow in said first region into said second region by centrifugal force and being directed back into said first region by the slope of said wall means.

The slope may extend downwardly to the outer edge of the annular fluid inlet means.

The circumferential wall means may comprise a cylindrical portion extending upwardly from a portion having said slope.

The chamber may include second circumferential wall means extending upwardly, and disposed radially inwardly, of said annular fluid inlet means.

This second circumferential wall means may

comprise at least a portion having a slope towards said annular fluid inlet means, which slope may extend to the radially inner edge of said annular fluid inlet means.

The means for directing fluid through said inlet into said first annular region with vertical and circumferential flow components may comprise an annular array of at least generally radially extending elongate passage means each of which has at least one side surface which is inclined such that flow upwardly through said passage means exits with a circumferential flow component.

These passage means may be provided in an annular wall portion, and for example each passage means may comprise a slot extending through said wall portion, both of the at least generally radially extending side surfaces of the slot being inclined circumferentially.

The annular array of passage means may be disposed beneath said annular fluid inlet means and said flow directing means may further comprise respective flow guiding means extending upwardly between said array and locations at or adjacent radially inner and outer edges of said annular inlet means for causing flow through said array to be confined substantially to said first region in the chamber.

One or each of said flow guiding means may comprise aperture means for directing fluid flow into

the flow through said array. Preferably said one or each flow guiding means comprises a circumferential wall portion provided with said aperture means. These aperture means may comprise circumferentially spaced apart elongate apertures, each having at least one side surface which is inclined such that flow therethrough exits with a circumferential flow component. Preferably these elongate apertures extend upwardly.

In order that the invention may be better understood, an embodiment thereof, which is given by way of example only, will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic axial cross-section of part of an apparatus for subjecting matter to fluid flow;

Figure 2 is a cross-section along the line II-II of Figure 1; and

Figure 3 is a perspective view of a radial portion of the apparatus.

Referring first to Figures 1 and 2, the illustrated apparatus comprises a chamber 10 having a circumferential wall 12 which is disposed radially outwardly of an annular fluid inlet 14. The wall 12 slopes towards the annular fluid inlet, and as shown comprises a cylindrical portion 16 extending upwardly from a sloping portion 18. In the illustrated apparatus, the sloping portion 18 extends downwardly to

the outer edge 20 of the annular fluid inlet.

Within the chamber 10 there is a first annular region disposed above the annular fluid inlet and designated 22 in Figure 1 and a second annular region contiguous with the first annular region and disposed between that region and the circumferential wall 12. The second region is disposed above the sloping portion 18 of the wall in the embodiment.

The apparatus also includes means for directing fluid through the annular inlet 14 with vertical and circumferential flow components. The direction of the fluid flow through the inlet is indicated in Figure 1 and Figure 3 by arrows 26 and 28. The flow of fluid through the inlet is such that it will move matter in the chamber 10 in a band continuously along an annular path in the regions 22, 24. This matter is moved vertically and circumferentially whilst in the first region 22 by the flow of fluid therein, is moved out of this flow of fluid in the first region into the second region by circumferential force and is directed back into the first region by the slope 18. The movement of the matter into and out of the flow of fluid is indicated by arrows 30 in Figures 1 and 3. It will be understood that whilst the matter is being circulated as indicated by arrows 30 it is also moving in the circumferential direction. Furthermore, it will be understood that when the matter moves into the outer

annular region 24 it is not subjected therein to the flow of the fluid and falls under gravity towards the annular inlet 14 whereupon it re-enters the fluid flow and is moved circumferentially and vertically by the fluid flow therein.

The fluid exits the chamber 10 upwardly as indicated by arrows 32 after it has passed through the annular region 22.

In the illustrated apparatus the chamber 10 includes a second circumferential wall 34 extending upwardly and disposed radially inwardly of the annular fluid inlet 14. This circumferential wall 34 has a slope towards the annular fluid inlet such that matter introduced centrally into the chamber as indicated by arrows 36 will be directed into the first annular region 22 above the annular fluid inlet 14. Whilst the whole of the second circumferential wall is provided with such a slope in the embodiment and this slope extends to the radially inner edge 38 of the annular fluid inlet 14, it is to be understood that only a portion of the circumferential wall 34 need be provided with such a slope and that slope need not extend to the edge 38.

Referring now particularly to Figure 3, the means for directing fluid through the annular inlet 14 with vertical and circumferential flow components in the illustrated apparatus comprises an annular array of

at least generally radially extending elongate passages 40. A portion of the annular array of passages is illustrated in Figure 2, however it is to be understood that the array extends completely around the annular inlet 14. Each passage 40 has at least one side surface which is inclined such that flow upwardly through the passage will exit with a circumferential flow component. In the illustrated apparatus the passages 40 are provided in an annular wall portion 42 and each passage comprises a slot extending through the wall portion, with both of the at least generally radially extending side surfaces 44, 46 of each slot being inclined in the circumferential direction. As shown the slots 40 and their side surfaces 44, 46 extend radially.

In order to cause the flow through the array of slots 40 to be confined substantially to the annular region above the fluid inlet 14, the flow directing means further comprises respective flow guiding means, generally indicated at 48 and 50 in Figure 3, extending upwardly between the array of slots 40 and locations at or adjacent the radially inner and outer edges 38, 20 of the annular inlet 14.

In the illustrated apparatus each flow guiding means 48, 50 comprises aperture means for directing

fluid flow into the flow through the array of slots 40. In Figures 1 and 3, the flow through the array is indicated by arrows 26 whilst the flow through the guiding means is indicated by arrows 28. It will be appreciated that the flow through the guiding means 48 has a radially outwardly as well as a circumferential component and the flow through the guiding means 50 has a radially inwardly as well as a circumferential flow component. Accordingly the respective flows through the guiding means 48 and 50 confine the flow through the array of slots 40 substantially to the annular region above the slots 40 and prevent the flow contacting the edges 20, 38 of the annular inlet 14.

The flow guiding means 48, 50 each comprises a circumferential wall portion provided with apertures 52 which are circumferentially spaced apart elongate apertures, having at least one side surface which is inclined such that the flow therethrough exits with a circumferential flow component as well as a radial flow component. In the illustrated apparatus the elongate apertures extend upwardly from the ends of slots 40.

The illustrated apparatus is particularly applicable for use in heating matter comprising a particulate material which has to be heated to a predetermined temperature, but which is adversely affected by being

continuously subjected to temperatures above that predetermined temperature during treatment.

In such an application a flow of heated fluid is provided to the first annular region 22 in the chamber 10 with vertical and circumferential components by virtue of its passage through the slots 40 and the apertures 52. The particulate matter to be heated is supplied to the chamber centrally thereof and is fed to the region 22 by the slope of the inner circumferential wall 34. This particulate material is then moved in a band continuously along an annular path in the regions 22 and 24. The particulate material is moved vertically and circumferentially by the fluid flow whilst in the first region, is moved out of the flow in the first region into the second region by circumferential force and is thereafter directed back into the first region by the slope 18 of the outer circumferential wall 12. Thus, the particulate material is moved in a band continuously around the regions 22, 34 whilst being circulated in this band between the regions such that the material moves into and out of the heated flow during movement around the regions. The fluid may be heated prior to and/or subsequent to its passage through the inlet 14. For example the fluid may comprise combustion gases, the combustion region of which is totally below the annular

inlet 14, is totally above the annular 14 or which spans the annular inlet 14.

It will be understood that alternative means to the provision of a slope such as slope 18, on the outer circumferential wall 16 may be provided for moving matter from annular region 24 back into annular region 22. For example, it is envisaged that such alternative means may comprise a plurality of fluid jets disposed around the outer circumferential wall and directed inwardly with at least a radial flow component for this purpose.

CLAIMS:

1. A process in which matter is subjected to fluid flow, comprising providing a flow of fluid in a first annular region having vertical and circumferential flow components, providing a second annular region contiguous with and disposed outwardly of said first region, moving matter in a band continuously around said regions while circulating matter in said band between said regions such that said matter moves into and out of said flow during movement around said regions.

2. A process as claimed in claim 1, wherein said matter is moved out of said first annular region by centrifugal force.

3. A process as claimed in claim 1 or 2, wherein matter is returned from said second annular region to said first annular region by a slope in a wall means bounding said second annular region.

4. A method as claimed in any one of the preceding claims, wherein there is a heat transfer between said matter and fluid flow.

5. Apparatus for subjecting matter to fluid flow, comprising a chamber having an annular fluid inlet means disposed beneath a first annular region in the chamber, the chamber having a second annular region contiguous with and disposed outwardly of the first

region between said first region and a circumferential wall means of the chamber, means for directing fluid flow through said inlet into said first annular region with vertical and circumferential flow components, and means for moving matter which has moved out of the flow in said first region into said second region by centrifugal force back into said first region.

6. Apparatus for subjecting matter to fluid flow comprising a chamber having a circumferential wall means extending upwardly, and disposed radially outwardly, of an annular fluid inlet means, at least a portion of said wall means having a slope towards said annular fluid inlet means whereby said chamber has a first annular region above said annular fluid inlet means and a second annular region between said first region and said wall means, means for directing fluid through said inlet means into said first annular region with vertical and circumferential flow components such that, in use, matter in said chamber is moved in a band continuously along an annular path in said regions, the matter being moved vertically and circumferentially whilst in said first region by the flow therein, being moved out of said flow in said first region into said second region by centrifugal force and being directed back into said first region by the slope of said wall means.

7. Apparatus as claimed in claim 6, wherein said

slope extends downwardly to the outer edge of said annular fluid inlet means.

8. Apparatus as claimed in claim 6 or 7, wherein said circumferential wall means comprises a cylindrical portion extending upwardly from a portion having said slope.

9. Apparatus as claimed in any one of claims 5 to 8, wherein said chamber includes second circumferential wall means extending upwardly, and disposed radially inwardly, of said annular fluid inlet means.

10. Apparatus as claimed in claim 9,wherein said second circumferential wall means comprises at least a portion having a slope towards said annular fluid inlet means.

11. Apparatus as claimed in claim 10, wherein said slope extends to the radially inner edge of said annular fluid inlet means.

12. Apparatus as claimed in any one of claims 5 to 11, wherein said means for directing fluid through said inlet into said first annular region with vertical and circumferential flow components comprises an annular array of at least generally radially extending elongate passage means each of which has at least one side surface which is inclined such that flow upwardly through said passage means exits with a circumferential flow component.

13. Apparatus as claimed in claim 12, wherein said passage means are provided in an annular wall portion,

14. Apparatus as claimed in claim 13, wherein each passage means comprises a slot extending through said wall portion, both of the at least generally radially extending side surfaces of the slot being inclined circumferentially.

15. Apparatus as claimed in any one of claims 12 to 14, wherein said annular array of passage means is disposed beneath said annular fluid inlet means and said flow directing means further comprises respective flow guiding means extending upwardly between said array and locations at or adjacent radially inner and outer edges of said annular inlet means for causing flow through said array to be confined substantially to said first region in the chamber.

16. Apparatus as claimed in claim 15, wherein one or each of said flow guiding means comprises aperture means for directing fluid flow into the flow through said array.

17. Apparatus as claimed in claim 16, wherein said one or each flow guiding means comprises a circumferential wall portion provided with said aperture means.

18. Apparatus as claimed in claim 16 or 17, wherein said aperture means comprise circumferentially spaced apart elongate apertures.

19. Apparatus as claimed in claim 18, wherein said

apertures each have at least one side surface which is inclined such that flow therethrough exits with a circumferential flow component.

20. Apparatus as claimed in claim 18 or 19, wherein said elongate apertures extend upwardly.

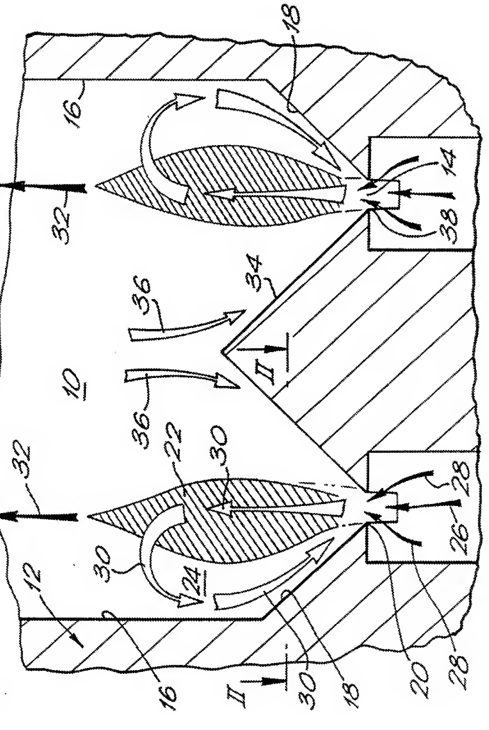


FIG.1.

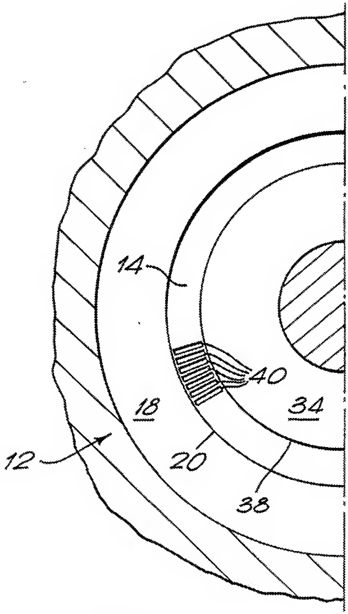


FIG. 2.

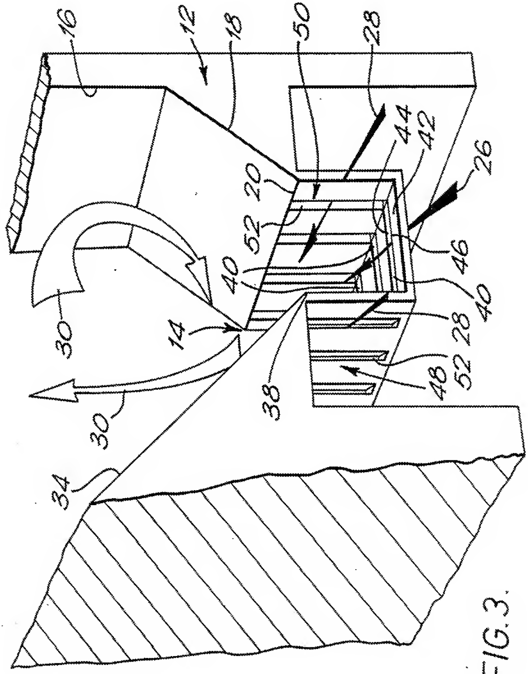


FIG. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00887

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: F 27 B 15/00; B 01 J 8/14; B 01 J 8/32

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	F 27 B, B 01 J; C 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A, 0068853 (JEZWORTH LTD) 5 January 1983 see claims and figures (cited in the application)	
A	EP, A, 0077294 (BATTELLE DEVELOPMENT) 20 April 1983 see claims and figures	
A	CH, A, 479498 (DENNERT KG) 28 November 1969 see claims and figures	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27th February 1989	11. 04. 89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. GB 8800887
SA 24800

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 05/04/89
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0068853	05-01-83	JP-A- 58008548	18-01-83
		AU-A- 8540982	06-01-83
		US-A- 4479920	30-10-84
		CA-A- 1190382	16-07-85
		US-A- 4559719	24-12-85
		AU-B- 554537	28-08-86
EP-A- 0077294	20-04-83	JP-A- 58064123	16-04-83
		CA-A- 1184743	02-04-85
CH-A- 479498	15-10-69	NL-A- 6504185	08-10-65
		US-A- 3432155	11-03-69
		LU-A- 48336	08-09-65
		DE-A- 1433927	04-09-69

EPO FORM P0479

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : F27B 15/00, B01J 8/14, 8/32

A1

(11) International Publication Number: WO 89/ 03968

(43) International Publication Date: 5 May 1989 (05.05.89)

(21) International Application Number: PCT/GB88/00887

(22) International Filing Date: 18 October 1988 (18.10.88)

(31) Priority Application Number: 8724873

(32) Priority Date: 23 October 1987 (23.10.87)

(33) Priority Country: GB

(71) Applicant *(for all designated States except US)*: TORFTECH LIMITED [GB/GB]; Mortimer Hill, Mortimer, Reading, Berkshire BG7 3PG (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : DODSON, Christopher, Edward [GB/GB]; Mortimer Hill, Mortimer, Reading, Berkshire BG7 3PG (GB).

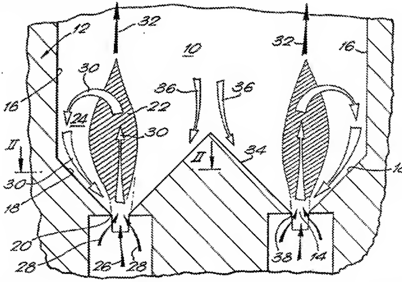
(74) Agents: ABBIE, Andrew, Kenneth et al.; R.G.C. Jenkins & Co., 26 Caxton Street, London SW1R 0RJ (GB).

(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PROCESSES IN WHICH MATTER IS SUBJECTED TO FLUID FLOW



(57) Abstract

Apparatus is provided for subjecting matter to fluid flow. The apparatus comprises a chamber (10) having an annular fluid inlet (14) beneath a first annular region (22) in the chamber. A second annular region (24) is contiguous with and disposed outwardly of the region (22) between the region (22) and a circumferential wall (12), which has a slope (18) towards the annular inlet (14). Means shown as an annular array of radially extending slots provided in an annular wall portion (Figure 3) direct fluid through the inlet (14) with vertical and circumferential flow components. In use matter in the chamber is moved in a band continuously along an annular path in the regions (22, 24). The matter is moved vertically and circumferentially whilst in the region (22) by the flow therein, is moved out of this flow into region (24) by circumferential force and is directed back into the region (22) by the slope (18) as indicated by arrows (30). Thus the matter is not continuously subjected to the fluid flow whilst being moved in its annular path in the chamber (10).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland				

PROCESSES IN WHICH MATTER IS SUBJECTED TO FLUID FLOW

This invention relates to processes in which matter is subjected to fluid flow.

In our specification EP-B-68853 there is disclosed apparatus comprising a chamber having an annular fluid inlet disposed beneath an annular region in the chamber and means for directing fluid flow through the inlet into said annular region with vertical and circumferential flow components for moving a bed of matter in the chamber in a band along an annular path in the annular region as the fluid passes through the bed.

This apparatus may be used for treating the fluid and/or the matter as the fluid passes through the bed of matter. During the treatment of matter and/or fluid in this way the matter is continuously in the flow of fluid as it moves along the annular path. In certain processes such continuous subjection of the matter to the fluid flow can be disadvantageous.

Accordingly, the present invention provides a process in which matter is subjected to fluid flow, comprising providing a flow of fluid in a first annular region having vertical and circumferential flow components, providing a second annular region contiguous with and disposed outwardly of said first region, moving matter in a band continuously around

said regions while circulating matter in said band between said regions such that said matter moves into and out of said flow during movement around said regions.

In a preferred embodiment of the invention to be described hereinafter the matter is moved out of the first annular region by centrifugal force and is returned from said second annular region to said first annular region by a slope in a wall means bounding said second annular region.

The process of the invention is particularly, but not exclusively, applicable where there is a heat transfer between the matter and the fluid flow.

The invention also includes apparatus for subjecting matter to fluid flow, comprising a chamber having an annular fluid inlet means disposed beneath a first annular region in the chamber, the chamber having a second annular region contiguous with and disposed outwardly of the first region between said first region and a circumferential wall means of the chamber, means for directing fluid flow through said inlet into said first annular region with vertical and circumferential flow components, and means for moving matter which has moved out of the flow in said first region into said second region by centrifugal force back into said first region.

The invention also includes apparatus for sub-

jecting matter to fluid flow comprising a chamber having a circumferential wall means extending upwardly and disposed radially outwardly, of an annular fluid inlet means, at least a portion of said wall means having a slope towards said annular fluid inlet means whereby said chamber has a first annular region above said annular fluid inlet means and a second annular region between said first region and said wall means, means for directing fluid through said inlet means into said first annular region with vertical and circumferential flow components such that, in use, matter in said chamber is moved in a band continuously along an annular path in said regions, the matter being moved vertically and circumferentially whilst in said first region by the flow therein, being moved out of said flow in said first region into said second region by centrifugal force and being directed back into said first region by the slope of said wall means.

The slope may extend downwardly to the outer edge of the annular fluid inlet means.

The circumferential wall means may comprise a cylindrical portion extending upwardly from a portion having said slope.

The chamber may include second circumferential wall means extending upwardly, and disposed radially inwardly, of said annular fluid inlet means.

This second circumferential wall means may

comprise at least a portion having a slope towards said annular fluid inlet means, which slope may extend to the radially inner edge of said annular fluid inlet means.

The means for directing fluid through said inlet into said first annular region with vertical and circumferential flow components may comprise an annular array of at least generally radially extending elongate passage means each of which has at least one side surface which is inclined such that flow upwardly through said passage means exits with a circumferential flow component.

These passage means may be provided in an annular wall portion, and for example each passage means may comprise a slot extending through said wall portion, both of the at least generally radially extending side surfaces of the slot being inclined circumferentially.

The annular array of passage means may be disposed beneath said annular fluid inlet means and said flow directing means may further comprise respective flow guiding means extending upwardly between said array and locations at or adjacent radially inner and outer edges of said annular inlet means for causing flow through said array to be confined substantially to said first region in the chamber.

One or each of said flow guiding means may comprise aperture means for directing fluid flow into

the flow through said array. Preferably said one or each flow guiding means comprises a circumferential wall portion provided with said aperture means. These aperture means may comprise circumferentially spaced apart elongate apertures, each having at least one side surface which is inclined such that flow therethrough exits with a circumferential flow component. Preferably these elongate apertures extend upwardly.

In order that the invention may be better understood, an embodiment thereof, which is given by way of example only, will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic axial cross-section of part of an apparatus for subjecting matter to fluid flow;

Figure 2 is a cross-section along the line II-II of Figure 1; and

Figure 3 is a perspective view of a radial portion of the apparatus.

Referring first to Figures 1 and 2, the illustrated apparatus comprises a chamber 10 having a circumferential wall 12 which is disposed radially outwardly of an annular fluid inlet 14. The wall 12 slopes towards the annular fluid inlet, and as shown comprises a cylindrical portion 16 extending upwardly from a sloping portion 18. In the illustrated apparatus, the sloping portion 18 extends downwardly to

the outer edge 20 of the annular fluid inlet.

Within the chamber 10 there is a first annular region disposed above the annular fluid inlet and designated 22 in Figure 1 and a second annular region contiguous with the first annular region and disposed between that region and the circumferential wall 12. The second region is disposed above the sloping portion 18 of the wall in the embodiment.

The apparatus also includes means for directing fluid through the annular inlet 14 with vertical and circumferential flow components. The direction of the fluid flow through the inlet is indicated in Figure 1 and Figure 3 by arrows 26 and 28. The flow of fluid through the inlet is such that it will move matter in the chamber 10 in a band continuously along an annular path in the regions 22, 24. This matter is moved vertically and circumferentially whilst in the first region 22 by the flow of fluid therein, is moved out of this flow of fluid in the first region into the second region by circumferential force and is directed back into the first region by the slope 18. The movement of the matter into and out of the flow of fluid is indicated by arrows 30 in Figures 1 and 3. It will be understood that whilst the matter is being circulated as indicated by arrows 30 it is also moving in the circumferential direction. Furthermore, it will be understood that when the matter moves into the outer

annular region 24 it is not subjected therein to the flow of the fluid and falls under gravity towards the annular inlet 14 whereupon it re-enters the fluid flow and is moved circumferentially and vertically by the fluid flow therein.

The fluid exits the chamber 10 upwardly as indicated by arrows 32 after it has passed through the annular region 22.

In the illustrated apparatus the chamber 10 includes a second circumferential wall 34 extending upwardly and disposed radially inwardly of the annular fluid inlet 14. This circumferential wall 34 has a slope towards the annular fluid inlet such that matter introduced centrally into the chamber as indicated by arrows 36 will be directed into the first annular region 22 above the annular fluid inlet 14. Whilst the whole of the second circumferential wall is provided with such a slope in the embodiment and this slope extends to the radially inner edge 38 of the annular fluid inlet 14, it is to be understood that only a portion of the circumferential wall 34 need be provided with such a slope and that slope need not extend to the edge 38.

Referring now particularly to Figure 3, the means for directing fluid through the annular inlet 14 with vertical and circumferential flow components in the illustrated apparatus comprises an annular array of

at least generally radially extending elongate passages 40. A portion of the annular array of passages is illustrated in Figure 2, however it is to be understood that the array extends completely around the annular inlet 14. Each passage 40 has at least one side surface which is inclined such that flow upwardly through the passage will exit with a circumferential flow component. In the illustrated apparatus the passages 40 are provided in an annular wall portion 42 and each passage comprises a slot extending through the wall portion, with both of the at least generally radially extending side surfaces 44, 46 of each slot being inclined in the circumferential direction. As shown the slots 40 and their side surfaces 44, 46 extend radially.

In order to cause the flow through the array of slots 40 to be confined substantially to the annular region above the fluid inlet 14, the flow directing means further comprises respective flow guiding means, generally indicated at 48 and 50 in Figure 3, extending upwardly between the array of slots 40 and locations at or adjacent the radially inner and outer edges 38, 20 of the annular inlet 14.

In the illustrated apparatus each flow guiding means 48, 50 comprises aperture means for directing

fluid flow into the flow through the array of slots 40. In Figures 1 and 3, the flow through the array is indicated by arrows 26 whilst the flow through the guiding means is indicated by arrows 28. It will be appreciated that the flow through the guiding means 48 has a radially outwardly as well as a circumferential component and the flow through the guiding means 50 has a radially inwardly as well as a circumferential flow component. Accordingly the respective flows through the guiding means 48 and 50 confine the flow through the array of slots 40 substantially to the annular region above the slots 40 and prevent the flow contacting the edges 20, 38 of the annular inlet 14.

The flow guiding means 48, 50 each comprises a circumferential wall portion provided with apertures 52 which are circumferentially spaced apart elongate apertures, having at least one side surface which is inclined such that the flow therethrough exits with a circumferential flow component as well as a radial flow component. In the illustrated apparatus the elongate apertures extend upwardly from the ends of slots 40.

The illustrated apparatus is particularly applicable for use in heating matter comprising a particulate material which has to be heated to a predetermined temperature, but which is adversely affected by being

continuously subjected to temperatures above that predetermined temperature during treatment.

In such an application a flow of heated fluid is provided to the first annular region 22 in the chamber 10 with vertical and circumferential components by virtue of its passage through the slots 40 and the apertures 52. The particulate matter to be heated is supplied to the chamber centrally thereof and is fed to the region 22 by the slope of the inner circumferential wall 34. This particulate material is then moved in a band continuously along an annular path in the regions 22 and 24. The particulate material is moved vertically and circumferentially by the fluid flow whilst in the first region, is moved out of the flow in the first region into the second region by circumferential force and is thereafter directed back into the first region by the slope 18 of the outer circumferential wall 12. Thus, the particulate material is moved in a band continuously around the regions 22, 34 whilst being circulated in this band between the regions such that the material moves into and out of the heated flow during movement around the regions. The fluid may be heated prior to and/or subsequent to its passage through the inlet 14. For example the fluid may comprise combustion gases, the combustion region of which is totally below the annular

inlet 14, is totally above the annular 14 or which spans the annular inlet 14.

It will be understood that alternative means to the provision of a slope such as slope 18, on the outer circumferential wall 16 may be provided for moving matter from annular region 24 back into annular region 22. For example, it is envisaged that such alternative means may comprise a plurality of fluid jets disposed around the outer circumferential wall and directed inwardly with at least a radial flow component for this purpose.

CLAIMS:

1. A process in which matter is subjected to fluid flow, comprising providing a flow of fluid in a first annular region having vertical and circumferential flow components, providing a second annular region contiguous with and disposed outwardly of said first region, moving matter in a band continuously around said regions while circulating matter in said band between said regions such that said matter moves into and out of said flow during movement around said regions.

2. A process as claimed in claim 1, wherein said matter is moved out of said first annular region by centrifugal force.

3. A process as claimed in claim 1 or 2, wherein matter is returned from said second annular region to said first annular region by a slope in a wall means bounding said second annular region.

4. A method as claimed in any one of the preceding claims, wherein there is a heat transfer between said matter and fluid flow.

5. Apparatus for subjecting matter to fluid flow, comprising a chamber having an annular fluid inlet means disposed beneath a first annular region in the chamber, the chamber having a second annular region contiguous with and disposed outwardly of the first

region between said first region and a circumferential wall means of the chamber, means for directing fluid flow through said inlet into said first annular region with vertical and circumferential flow components, and means for moving matter which has moved out of the flow in said first region into said second region by centrifugal force back into said first region.

6. Apparatus for subjecting matter to fluid flow comprising a chamber having a circumferential wall means extending upwardly, and disposed radially outwardly, of an annular fluid inlet means, at least a portion of said wall means having a slope towards said annular fluid inlet means whereby said chamber has a first annular region above said annular fluid inlet means and a second annular region between said first region and said wall means, means for directing fluid through said inlet means into said first annular region with vertical and circumferential flow components such that, in use, matter in said chamber is moved in a band continuously along an annular path in said regions, the matter being moved vertically and circumferentially whilst in said first region by the flow therein, being moved out of said flow in said first region into said second region by centrifugal force and being directed back into said first region by the slope of said wall means.

7. Apparatus as claimed in claim 6, wherein said

slope extends downwardly to the outer edge of said annular fluid inlet means.

8. Apparatus as claimed in claim 6 or 7, wherein said circumferential wall means comprises a cylindrical portion extending upwardly from a portion having said slope.

9. Apparatus as claimed in any one of claims 5 to 8, wherein said chamber includes second circumferential wall means extending upwardly, and disposed radially inwardly, of said annular fluid inlet means.

10. Apparatus as claimed in claim 9,wherein said second circumferential wall means comprises at least a portion having a slope towards said annular fluid inlet means.

11. Apparatus as claimed in claim 10, wherein said slope extends to the radially inner edge of said annular fluid inlet means.

12. Apparatus as claimed in any one of claims 5 to 11, wherein said means for directing fluid through said inlet into said first annular region with vertical and circumferential flow components comprises an annular array of at least generally radially extending elongate passage means each of which has at least one side surface which is inclined such that flow upwardly through said passage means exits with a circumferential flow component.

13. Apparatus as claimed in claim 12, wherein said passage means are provided in an annular wall portion,

14. Apparatus as claimed in claim 13, wherein each passage means comprises a slot extending through said wall portion, both of the at least generally radially extending side surfaces of the slot being inclined circumferentially.

15. Apparatus as claimed in any one of claims 12 to 14, wherein said annular array of passage means is disposed beneath said annular fluid inlet means and said flow directing means further comprises respective flow guiding means extending upwardly between said array and locations at or adjacent radially inner and outer edges of said annular inlet means for causing flow through said array to be confined substantially to said first region in the chamber.

16. Apparatus as claimed in claim 15, wherein one or each of said flow guiding means comprises aperture means for directing fluid flow into the flow through said array.

17. Apparatus as claimed in claim 16, wherein said one or each flow guiding means comprises a circumferential wall portion provided with said aperture means.

18. Apparatus as claimed in claim 16 or 17, wherein said aperture means comprise circumferentially spaced apart elongate apertures.

19. Apparatus as claimed in claim 18, wherein said

apertures each have at least one side surface which is inclined such that flow therethrough exits with a circumferential flow component.

20. Apparatus as claimed in claim 18 or 19, wherein said elongate apertures extend upwardly.

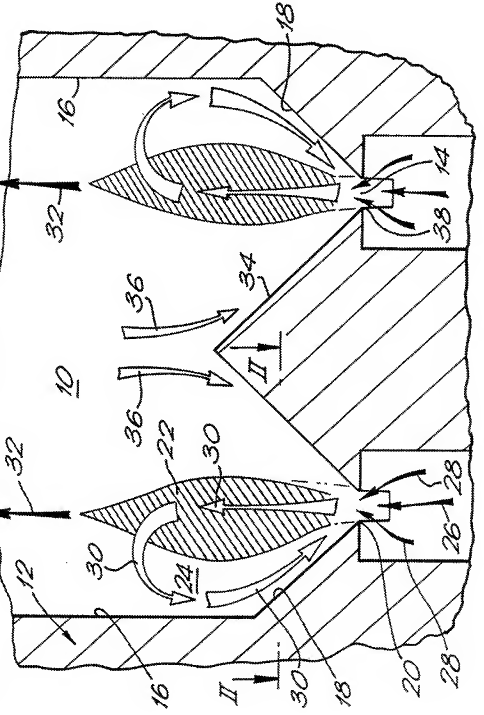


FIG.1.

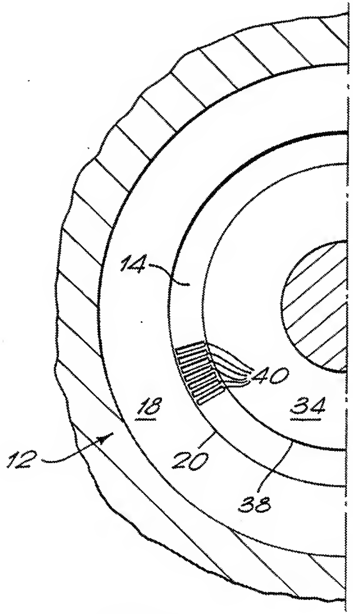


FIG. 2.

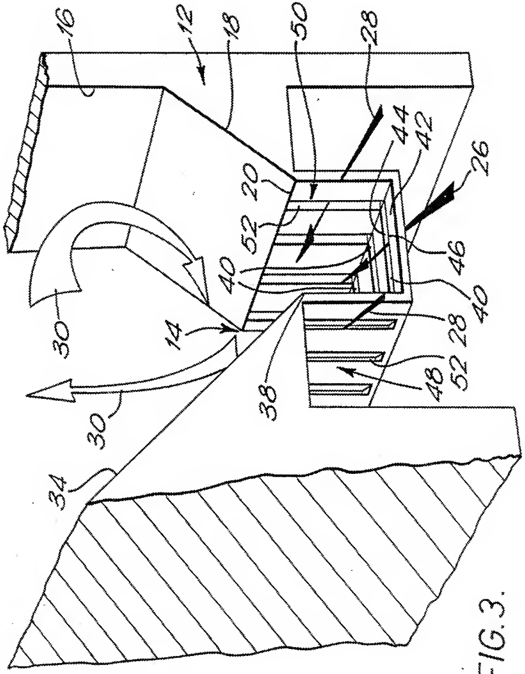


FIG. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00887

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: F 27 B 15/00; B 01 J 8/14; B 01 J 8/32

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	F 27 B, B 01 J; C 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A, 0068853 (JEZWORTH LTD) 5 January 1983 see claims and figures (cited in the application)	
A	EP, A, 0077294 (BATTELLE DEVELOPMENT) 20 April 1983 see claims and figures	
A	CH, A, 479498 (DENNERT KG) 28 November 1969 see claims and figures	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27th February 1989	11. 04. 89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. GB 8800887
SA 24800

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 05/04/89
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0068853	05-01-83	JP-A- 58008548	18-01-83
		AU-A- 8540982	06-01-83
		US-A- 4479920	30-10-84
		CA-A- 1190382	16-07-85
		US-A- 4559719	24-12-85
		AU-B- 554537	28-08-86
EP-A- 0077294	20-04-83	JP-A- 58064123	16-04-83
		CA-A- 1184743	02-04-85
CH-A- 479498	15-10-69	NL-A- 6504185	08-10-65
		US-A- 3432155	11-03-69
		LU-A- 48336	08-09-65
		DE-A- 1433927	04-09-69

EPO FORM P0479

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 941 668 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 158(3) EPC

(43) Date of publication:
15.09.1999 Bulletin 1999/37

(21) Application number: 97944142.5

(22) Date of filing: 16.10.1997

(51) Int. Cl.[6]: A23G 9/00

(86) International application number:
PCT/JP97/03736

(87) International publication number:
WO 98/16120 (23.04.1998 Gazette 1998/16)

(84) Designated Contracting States:
DE ES FR GB IT

(30) Priority: 16.10.1996 JP 29313196
21.10.1996 JP 29707696
21.10.1996 JP 29707796

(71) Applicant:
Nikken Chemicals Company, Limited
Tokyo 104 (JP)

(72) Inventors:
- HAYASHI, Kaoru,
  Nikken Chem Co Ltd Omiya Res lab
  Omiya-shi Saitama 330 (JP)
- KOHNO, Hiroyuki,
  Nikken Fine Chem. Co. Ltd.
  Chita-shi Aichi 478 (JP)
- NAKASHIMA, Kyoko,
  Nikken Fine Chemicals Co., Ltd.
  Chita-shi Aichi 478 (JP)
- URAJI, Tatsuya,
  Nikken Fine Chemicals Co., Ltd.
  Chita-shi Aichi 478 (JP)

(74) Representative:
VOSSIUS & PARTNER
Siebertstrasse 4
81675 München (DE)

Remarks:
A request for correction of the description has been filed pursuant toRule 88 EPC. A decision will be taken during the proceedings before the Examining Division.

(54) SHERBETS AND PROCESSES FOR THE PRODUCTION THEREOF

(57) The first aspect of the present invention relates to a sherbet which contains erythritol and provides a soft mouthfeel and also to a process for producing it.

The second aspect of the present invention relates to an erythritol-containing alcoholic soft sherbet to be served as a soft ice-like frozen alcoholic beverage and a process for producing it and also to a solution as a raw material from which the erythritol-containing alcoholic soft sherbet is produced.

According to the first aspect of the present invention, even if erythritol is used, the hardness of frozen sherbet does not increase. As a result, there can be obtained a sherbet that has a low calorific value and a soft mouthfeel even it is readily spooned as soon as it is taken out of the freezer.

The erythritol-containing alcoholic soft sherbet according to the second aspect of the present invention has a low calorific value, a low degree of sweetness, and a low sugar content, and it is served to eat and drink as a soft ice-like frozen alcoholic beverage in the form of soft ice which can be made in the freezing compartment of a home refrigerator.

EP 0 941 668 A1

Description

Technical Field

[0001] The present invention relates to a sherbet and a process for the production thereof, and are particularly, to an erythritol-containing sherbet and a process for the production thereof.
[0002] The present invention may be broadly classified into two aspects both of which relate to an erythritol-containing soft sherbet.
[0003] That is, the first aspect of the present invention relates to an erythritol-containing soft sherbet and a process for the production thereof, which are described in Claims 1 to 17.
[0004] Next, the second aspect of the present invention relates to an erythritol-containing alcoholic soft sherbet to be served as a soft ice-like frozen alcoholic beverage and a process for the production thereof and also relates to an aqueous solution as a raw material from which the erythritol-containing alcoholic soft sherbet is made, which are described in Claims 18 to 31.
[0005] Accordingly, descriptions will be made of two aspects of the present invention separately.

Background Art

(First aspect of the invention)

[0006] To start with, the first aspect of the invention is explained in the following.
[0007] As mentioned above, the first aspect of the present invention relates to an erythritol-containing soft sherbet and a process for the production thereof.
[0008] Erythritol is a sugar alcohol that is used as a sweetener for confectionery, beverages, and foods. Having no calorific value, it especially finds use as a sweetener for dietetic foods. In addition, it is expected to find use not only as a sweetener for ordinary foods but also as a sweetener for diabetics and other patients suffering from derangement of carbohydrate metabolism who cannot assimilate saccharide such as sucrose and glucose.
[0009] For this reason, there has been proposed using erythritol for a sherbet as a dietetic food with reduced calorific values or a sherbet for diabetics. Unfortunately, there has been a prevalent belief that sherbet that contains erythritol in place of sucrose or glucose is too hard to spoon and hence erythritol is not suitable as a sweetener for sherbet.
[0010] As for a sherbet containing erythritol, Japanese Patent Publication No. Hei 7-100013 discloses that erythritol can be used as a sweetener for dessert such as sherbet. However, it does not disclose nothing in particular about the production process.
[0011] The present inventors' experiments in sherbet production in the usual way, with erythritol in place of sucrose (as a sweetener), confirmed that the hardness upon freeze becomes higher. More specifically, it was confirmed that the resulting sherbet remains too hard to spoon and therefore to eat for a while after it has been taken out of a freezer because the sherbet mix freezes rapidly during cooled agitation for whipping air into the sherbet, so that it does not contain air sufficiently therein.
[0012] Japanese Patent Application Laid-open No. Hei 6-70689 discloses a process for making a soft frozen dessert by whipping air into a syrup containing sugar, foaming agent, and foam stabilizer, mixing the resulting whipped syrup with ice, and performing further whipping air into syrup. For the resulting product to be soft, this process needs the steps of whipping air into syrup, mixing the whipped syrup with ice, and performing further whipping air into syrup. The air content (or overrun) in the ice-syrup mixture is 20-100%. The problem with this process is complexity, with necessity to carry out whipping air into syrup twice, to prepare ice for addition to syrup, and to perform separately a process of whipping air into syrup and a process of allowing ice crystals to grow.
[0013] Japanese Patent Application Laid-open No. Hei 4-23952 discloses a coating material for frozen desserts, which contains gelatin and sugar alcohol. This coating material is, however, for the purpose of coating the surface of frozen desserts such as ice cream and sherbet, and when the amount of gelatin contained in the coating material is increased to 5-15 wt%, jelly mouthfeel can be imparted. The gelatin and sugar alcohol are not used as raw material of sherbet itself.
[0014] It is an object of a first aspect of the present invention to provide an erythritol-containing sherbet and a process for the production thereof, in which the sherbet contains erythritol as a sweetener so that it has a greatly reduced calorific value unlike conventional sherbets. It is further object to provide an erythritol-containing soft sherbet having a soft mouthfeel and a process for the production thereof, in which the sherbet is readily spooned as soon as it is taken out of a freezer

(Second aspect of the invention)

[0015] Next, the second aspect of the invention is explained in the following.

[0016] The second aspect of the invention relates to an erythritol-containing alcoholic soft sherbet that has a low calorific value and can be frozen simply in the freezing compartment of an ordinary home refrigerator to be in a soft-ice-cream-like state, which is capable of enjoying and tasting as a frozen alcoholic beverage resembling soft ice, and the process for the production thereof, and also to an aqueous solution as the raw material from which the erythritol-containing alcoholic soft sherbet is made. Here enjoying and tasting have a concept of eating and drinking.

[0017] There have been proposed a variety of frozen alcoholic beverages (so-called frozen cocktails) produced by freezing alcoholic beverages such as cocktails.

[0018] For example, Japanese Patent Application Laid-open No. Hei 8-70810 discloses a process for producing a sherbet containing plum extract obtained from "plum liqueur."

[0019] According to this invention, there is a description that it yields a sherbet having a good flavor and a good mouthfeel with an adequate viscosity.

[0020] However, what it actually yields is not the soft ice-like frozen alcoholic beverage intended by the present invention but is a rather hard sherbet obtained by simple freezing without attention to reduction in the hardness upon freezing.

[0021] Then, Japanese Patent Publication No. Hei 7-77553 discloses a process for making a sherbet-like frozen beverage.

[0022] According to this invention, there is a description that the production of a frozen beverage with a low sugar content (less than ca. 15°) and a low alcohol concentration (less than ca. 10°) in the form of sherbet with adequate squeezability.

[0023] The process of this invention consists of steps of cutting ice blocks into small pieces or granules, cooling the alcoholic beverage below the freezing point, and uniformly mixing the cooled alcoholic beverage with the cut ice pieces at an atmosphere of a temperature lower than the freezing point of the alcoholic beverage, thereby forming a frozen layer of the cooled alcoholic beverage on the surface of and between the interstices of said cut ice pieces. That beverage requiring such complex steps is far remote from the beverage of the present invention which is made by simply freezing a liquid alcoholic beverage in the freezing compartment of an ordinary home refrigerator.

[0024] Incidentally, several frozen alcoholic beverages (or frozen cocktails) are commercially available. For example, commercial frozen strawberry daiquiri or frozen melon daiquiri contains about 8% alcohol but contains total saccharides as high as about 28% so that it resembles soft ice. Thus, they are calorific as well as sweet. On the other hand, commercial frozen margarita contains total saccharides in a reduced amount of about 23%, avoiding the problem of being sugary, but contains about 10% alcohol (which is higher than that (4-8%) of commercial cocktail beverages) accompanied with a high calorific value, the problem remained unresolved.

[0025] Moreover, Japanese Patent Application Laid-open No. Sho 63-160572 discloses a frozen alcoholic beverage which is prepared by freezing an alcoholic beverage composed of water, sugar, alcohol, flavor, and carboxymethylcellulose in a freezer to be in a soft ice state and is stored as such until it is served.

[0026] This frozen alcoholic beverage has no problem with sweetness in view of its Brix degree ranging from ca. 15° to ca. 28°, preferably from ca. 18° to ca. 25°. On the other hand, it contains as much alcohol as 15-20wt% in order to keep a soft ice state. Because of its higher alcohol concentration compared with, not to mention commercial cocktails (4-8% alcoholic concentration), commercial frozen cocktails (with about 8-10 wt% alcohol), it is unpalatable and calorifacient.

[0027] The sugar concentration and alcohol concentration affect the freeze hardness in a contradictory manner. Reducing the sugar concentration to lessen sweetness ends up with an increase in freeze hardness which prevents the formation of products in a soft ice state. Any attempt to reduce the freeze hardness requires an increase in alcohol concentration which results in unpalatable high-calorie products. Reducing the alcohol concentration while keeping the sugar concentration high leads to low freeze hardness contributing to the soft ice state at the expense of increase in calorific value and sweetness.

[0028] As a matter of fact, there has not been obtained so far any frozen alcoholic beverage with low calorie in a soft ice state, particularly the one in a soft ice state which has a moderate alcohol concentration and a low sugar concentration for low calorie.

[0029] Under these circumstances, there is a demand for the development of a frozen alcoholic beverage which has a low degree of freeze hardness, takes on a soft ice state, and is of low calorie, particularly the one which is comparatively low in alcohol concentration and is in the form of soft ice with low freeze hardness and with low calorie and further is ready for enjoying and tasting after simple freezing in the freezing compartment of a home refrigerator.

[0030] Addressing this problem is an object of the second aspect of the present invention.

[0031] It is known that the concentration of alcohol and saccharides in a frozen alcoholic beverage has a profound effect on freezing and freezability. An increase in their concentration lowers the freezing point and prevents the growth

of ice crystals. Particularly, an increase in saccharide concentration leads to smaller ice crystals.

[0032] Consequently, for a frozen alcoholic beverage to assume a soft ice state by freezing in the freezer compartment of a home refrigerator, it should have a comparatively high saccharide concentration and an adequate alcohol concentration corresponding to it.

[0033] Unfortunately, as mentioned above, if the alcohol concentration is maintained at an adequately low level, it is necessary to increase the saccharide concentration to some extent so that the frozen alcoholic beverage assumes a soft ice state with low freeze hardness. This poses a problem of high calorie.

[0034] In order to address the foregoing problem, the present inventors carried out a series of researches which led to the finding that it is possible to lower freeze hardness while reducing the calorific value by employing at least a sugar alcohol as the saccharide for a soft ice-like frozen alcoholic beverage. Because a sugar alcohol is less sweet than sucrose and isomerized sugar, it was further found that the beverage containing it is moderately sweet and palatable.

[0035] It is known that there is a positive correlation between the freeze hardness of a frozen alcoholic beverage and the difference between its freezing point and its freeze storage temperature. In other words, it is known that a frozen alcoholic beverage becomes softer as its freezing point approaches its freeze storage temperature (or as their difference decreases).

[0036] In addition, it has also been found that the higher ice fraction (for the same solvent) becomes, the higher the freeze hardness becomes, and the higher the molecular weight and solubility of the used saccharific solute (sugar and sugar alcohol) becomes, the higher the freeze hardness becomes. In other words, the lower the molecular weight of the solute becomes, the lower the freeze hardness becomes.

[0037] This implies that the freeze hardness depends heavily on kinds of saccharide, concentration, molecular weight, and solubility. These factors determine ice fraction, freezing point, glass transition point, and viscosity in that part of solution which has been frozen and concentrated. The overall results thereof manifest themselves in freeze hardness.

[0038] The above-mentioned findings are the basis for the selection of erythritol as a desirable sugar alcohol from among low-molecular weight saccharides.

[0039] Incidentally, erythritol has never been used for alcoholic beverages.

[0040] Having a low molecular weight, in spite of having less sweetness than saccharide and thus having the effect of low saccharide concentration, erythritol lowers the freezing point of its aqueous solution with a less amount (hence with a lower degree of sweetness), resulting in lower freeze hardness. In other words, erythritol reduces the freezing point much more than sucrose if the sugar concentration and sweetness are the same.

[0041] Incidentally, it was found that xylitol lowers the freezing point and freeze hardness when used in a less amount than sucrose because it has a lower molecular weight than sucrose although it is as sweet as sucrose. In other words, xylitol lowers the freezing point more than sucrose for the same sugar concentration. This permits its use in combination with erythritol.

[0042] The fact that erythritol has a zero calorific value and xylitol has a calorific value lower than that of other saccharides (such as sucrose) by about 25% contributes to low-calorie alcoholic beverages.

[0043] The second aspect of the present invention is based on these findings. It is intended to provide an erythritol-containing alcoholic soft sherbet to be served as a soft ice-like frozen alcoholic beverage which has a low calorific value and a low degree of freeze hardness owing to the use of reduced amount of alcohol (within a certain range of alcohol concentration) and the use of sugar alcohol (including at least erythritol) as saccharide. It is also intended to provide a process for producing an erythritol-containing alcoholic soft sherbet to be served as a soft ice-like frozen alcoholic beverage by simple freezing in the freezing compartment in a home refrigerator without necessity for complex steps. It is also intended to provide an aqueous solution as a raw material from which the erythritol-containing alcoholic soft sherbet is made.

Disclosure of the Invention

(The first aspect of the invention)

[0044] In order to address the above-mentioned problem, the present inventors carried out a series of researches which led to the finding that a sherbet containing erythritol as a sweetener has a soft mouthfeel if it undergoes overrun on a sherbet mix in a range of 50 to 130% and that the desired overrun can be accomplished by the conventional freezing technique without necessity for special steps, if a foam stabilizer is incorporated with a sherbet mix containing erythritol.

[0045] The gist of the first aspect of the present invention resides in a sherbet which contains erythritol and provides a soft mouthfeel as defined in Claim 1, a process for producing a sherbet which comprises stirring a sherbet mix composed of water, erythritol, and gelatin or pectin as a foam stabilizer for whipping air into syrup with cooling until overrun reaches 60-110%, thereby causing ice crystals to separate out as defined in Claim 11, and a process for producing a sherbet which comprises stirring a sherbet mix composed of water, erythritol, at least one member selected from the

group consisting of sugar, sugar alcohol, and polydextrose, and egg white as a foam stabilizer for whipping air into syrup with cooling until overrun reaches 50-90%, thereby causing ice crystals to separate out as defined in Claim 16. The sherbet defined in Claim 1 can be produced basically by the process defined in Claim 11 or Claim 16

(The second aspect of the present invention)

[0046] The second aspect of the present invention is intended to provide an erythritol-containing alcoholic sherbet which is served as a soft ice-like frozen alcoholic beverage and a process for producing the same, and to provide a solution as a raw material from which the erythritol-containing alcoholic soft sherbet is made.
[0047] More specifically, an object of the present invention is to provide the sherbet according to Claim 1 which is an alcoholic sherbet containing alcohol in an amount from 1 to 18 vol% (w/v), as defined in Claim 18.
[0048] Another object of the present invention is to provide a process for producing a sherbet which comprises stirring and mixing together an alcoholic ingredient, erythritol alone or a mixture of erythritol and xylitol, optional saccharides other than erythritol and xylitol, and a thickening and stabilizing agent, and subsequently freezing the resulting mixture, as defined in Claims 24 to 27.
[0049] Further another object is to provide an aqueous solution as a raw material from which a sherbet is made, the aqueous solution comprising an alcoholic ingredient, erythritol alone or a mixture of erythritol and xylitol, optional saccharides other than erythritol and xylitol, and a thickening and stabilizing agent, as defined in Claims 28 to 31.

Best Mode for carrying out the Invention

(The first aspect of the invention)

[0050] What follows is a detailed description of the first aspect of the present invention.
[0051] The gist of the first aspect of the present invention resides in a sherbet that contains erythritol and has a soft mouthfeel as defined in Claim 1 (which has been mentioned above).
[0052] The present inventors are the first to develop a sherbet that contains erythritol and has a soft mouthfeel as defined in Claim 1.
[0053] The sherbet as defined in Claim 1 can be made efficiently by the process as defined in Claims 11 to 17.
[0054] The erythritol is a sugar alcohol of tetrose as a sweetener, and any commercial one is acceptable. It may be used in the form of crystals, powder, or liquid, which is not specifically restricted.
[0055] The invention defined in Claim 1 is augmented in Claims 2 and 3 as follows.
[0056] In Claim 2, the sherbet defined in Claim 1 is characterized further by erythritol and foam stabilizer contained therein and overrun ranging from 50 to 130%.
[0057] In Claim 3, the sherbet defined in Claim 1 is characterized further by erythritol, foam stabilizer, and at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose contained therein and overrun ranging from 50 to 130%.
[0058] Generally, sucrose or the like as a sweetener is used in an amount of 10-35 wt% of the sherbet mix.
[0059] In the case where the erythritol as a sweetener is used alone as in Claim 2, the amount of erythritol to be used is equivalent to give sweetness comparable to that of sucrose or the like as a sweetener used in an ordinary sherbet. In general, 10-35 wt% per sherbet mix is used so that the amount may be determined within this range.
[0060] The sherbet as defined in Claim 2 contains erythritol alone (100%) as a sweetener so that it is spooned easily, as explained above. The erythritol may be used in combination with any other sweeteners than erythritol.
[0061] As a sweetener, there are exemplified by sugar (such as sucrose, glucose, fructose, high fructose corn syrup, palatinose, trehalose, and starch syrup), sugar alcohol (such as glycerin, xylitol, sorbitol, maltitol, lactitol, palatinit, and hydrogenated glucose syrup), oligosaccharide (such as isomaltooligosaccharide, fructooligosaccharide, galactooligosaccharide, xylooligosaccharide, and oligosaccharides), and non-sugar sweeteners (such as aspartame, stevioside, rebaudioside, acesulfame K, glycyrrhizin, thaumatin, and sodium saccharin).
[0062] Erythritol is less sweet than sucrose, with a sweetness being about 80% of that of sucrose. Its sweetness may be supplemented by other sweeteners, especially non-sugar sweeteners having a high degree of sweetness, such as aspartame, stevioside, rebaudioside, acesulfame K, glycyrrhizin, thaumatin, and sodium saccharin, mentioned above.
[0063] Meanwhile, the sherbet as defined in Claim 3 contains erythritol in combination with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose.
[0064] Examples of the sugar include those mentioned above. They have an approximate calorific value of 4 kcal/g. Examples of the sugar alcohol include those mentioned above. They have a calorific value of 2 kcal/g, except for glycerin (4 kcal/g) and hydrogenated glucose syrup (2-4 kcal/g). Polydextrose used is commercially available; it has a calorific value of 1 kcal/g.
[0065] The sugar, sugar alcohol, and polydextrose may be used alone or in combination with one another. Sucrose,

lactitol, or polydextrose is preferable as defined in Claims 7 and 8.

[0066] In the case where erythritol as a sweetener is used in combination as in the sherbet defined in claim 3 with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose, the amount of erythritol varies depending on other sweeteners used in combination.

[0067] When erythritol is used in combination with saccharides, as in claim 9, a preferred amount of erythritol is not less than 50 wt% and less than 100 wt% of total amount of the erythritol and saccharides to have a low calorific value. In the case where erythritol is used in combination with sugar alcohol, polydextrose, or cellulose, a preferred amount of erythritol is not less than 25 wt% and less than 100 wt% of their total amount.

[0068] The first aspect of the present invention slightly varies in constituent depending on the kind of foam stabilizer employed.

[0069] That is, in the case where the foam stabilizer is gelatin or pectin as in Claims 4 and 5, a preferred overrun is 60-110%. With an overrun of 50-130%, preferably 60-110%, a sherbet mix containing erythritol alone as a sweetener yields a sherbet having a soft mouthfeel by the conventional freezing technique without necessity for special steps.

[0070] On the other hand, in the case where the foam stabilizer is egg white as in Claim 6, a preferred overrun is 50-90%.

[0071] In said case where egg white is employed as foam stabilizer, a sherbet containing erythritol alone as a sweetener is low in overrun and hence is poor in mouthfeel.

[0072] To cope with this, it is necessary for the sherbet to contain erythritol in combination with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose. The overrun in this case should sufficiently be from 50% to 90%, 90% of overrun is enough at highest.

[0073] Needless to say, the sherbet may contain erythritol in combination with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose even in the case where the foam stabilizer is gelatin or pectin as defined in Claim 5.

[0074] Incidentally, in either case where the foam stabilizer is gelatin or pectin or where the foam stabilizer is egg white, the foam stabilizer may be used in combination with a polysaccharide thickener (such as carrageenan, guar gum, tamarind gum, pectin, xanthane gum, agar, locust bean gum, gum arabic, and alginic acid) or a protein (such as gelatin, gluten, egg white, and egg white albumin) so long as they do not detract the feature of the present invention, for the purpose of foam stabilizing.

[0075] The foam stabilizer should be used in a varied amount depending on its kind; an adequate amount is such as to produce a stable overrun of 50-130% and to give a viscosity high enough for the sherbet mix to be stirred and mixed.

[0076] Usually, the foam stabilizer is used in an amount of about 0.05-5 vol% of the sherbet mix. For example, a preferred amount of gelatin is 0.05-2 vol%, particularly 0.4-1 vol% is preferable, and a preferred amount of pectin is 1-3 vol%. When the amount of gelatin exceeds 1 vol% or the amount of pectin exceed 3 vol%, a jelly mouthfeel is imparted to the sherbet more and more respectively as the amount thereof increases, although the resulting sherbet is still acceptable as a frozen dessert.

[0077] The egg white used as a foam stabilizer in the sherbet defined in Claim 6 may be raw egg white (left after removal of yolk from whole egg) or commercially available egg white in the form of powder or liquid or egg white albumin. Raw egg white should be used in an amount of about 5-15 vol% of the sherbet mix. With an amount less than 5 vol%, the resulting sherbet is hard and poor in mouthfeel. With an amount more than 15 vol%, the resulting sherbet gives rise to bubbles on its surface, detracting its mouthfeel, as it melts.

[0078] The sherbet according to the first aspect of the present invention has its soft mouthfeel enhanced if it is incorporated with alcohol during its production as defined in Claim 10.

[0079] Alcohol in an amount less than 1 vol% of the sherbet mix is enough. The alcohol used may be ethyl alcohol. Liqueur or fruit wine is preferable to impart a flavor to the sherbet. When using alcohol for the purpose of imparting a flavor, their amount may exceed 1 vol% in terms of alcohol.

[0080] What follows is a description of the process for making an erythritol-containing soft sherbet according to the first aspect of the present invention mentioned above.

[0081] According to the first aspect of the present invention, the erythritol-containing soft sherbet is made from a sherbet mix by whipping air into syrup and freezing to form fine ice crystals, the sherbet mix being prepared from water, erythritol, foam stabilizer, and optional alcohol by mixing for dissolution. The process slightly differs in condition depending on whether the foam stabilizer is either gelatin or pectin or egg white, as respectively explained below.

[0082] First, the process in which the foam stabilizer is either gelatin or pectin is described in Claims 11 to 15.

[0083] As described in Claim 11, the desired erythritol-containing soft sherbet is made from a sherbet mix composed of water, erythritol, and either gelatin or pectin as a foam stabilizer by stirring with cooling, whipping air into syrup until overrun reaches 60-110%, and freezing until ice crystals separate out.

[0084] In this case, overrun should be 60-110%, preferably 60-90% for the sherbet especially to have a soft mouthfeel and to readily thaw in the mouth. A sherbet with overrun less than 60% is too hard to be eaten for a while after it has been taken out of the freezer. By contrast, a sherbet with overrun more than 90% unpreferably thaws too fast before it

gives a cold sense to the mouth.

[0085] In the case where the foam stabilizer is either gelatin or pectin, as in Claim 12, the sherbet may contain erythritol as a sweetener in combination with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose.

[0086] Moreover, the process according to Claim 11 or 12 may be modified such that the sherbet mix contains optional alcohol as defined in Claim 13.

[0087] Incidentally, a preferred amount of gelatin is 0.05-2 vol%, particularly 0.4-1 vol%, of the sherbet mix, and a preferred amount of pectin is 1-3 vol% of the sherbet mix. When the amount of gelatin exceeds 1 vol% or the amount of pectin exceed 3 vol%, a jelly mouthfeel is imparted to the sherbet more and more respectively as the amount thereof increases, although the resulting sherbet is still acceptable as a frozen dessert.

[0088] By the way, freezing may be accomplished by using any apparatus capable of stirring a pasty material under cooling condition. Such apparatus include commercial beaters (such as ice cream maker and whip cream mixer) and mixers (such as propeller mixer, homomixer, high-speed mixer, static mixer, and extruder).

[0089] Freezing may be accomplished by cooling the prepared sherbet mix in a cold storage container and subsequently stirring it in the same container or in a separate previously cooled mixer (as in the case of commercial ice cream maker). Alternatively, freezing may be accomplished by using a mixer equipped with a cooling mechanism. During freezing, the temperature of the sherbet mix should be kept below its freezing point. The sherbet mix varies in freezing point depending on the amount of saccharide it contains. The freezing point is -1.5°C or lower if the amount of saccharide used is 10 wt%, and the freezing point is -5.5°C or lower if the amount of saccharide used is 35 wt%.

[0090] After freezing, the sherbet mix undergoes packaging in adequate containers (such as cups and cones), followed by cooking and solidifying in a freezer. Thus there is obtained the sherbet.

[0091] The sherbet mix in the first aspect of the present invention may properly be incorporated with additives, in addition to the above raw materials, including taste elements (such as fruit juice, milk products, and fats and oils), flavors, food colors, acidulant, pH adjusting agents, emulsifiers, and foaming agents.

[0092] Second, the process in which the foam stabilizer is egg white is described in Claims 16 and 17. This process is identical with that in Claims 11 to 15 except for the following.

[0093] That is, as described in Claim 16, the desired erythritol-containing soft sherbet is made from a sherbet mix composed of water, erythritol, at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose, and egg white as a foam stabilizer by stirring with cooling, whipping air into syrup until overrun reaches 50-90%, and freezing until ice crystals separate out. In this process, overrun should sufficiently be from 50 to 90%, and 90% of overrun is enough at highest.

[0094] Egg white in the form of raw egg white may be added as such when the sherbet mix is prepared. More preferably is that the sherbet mix prepared with raw materials except raw egg and then cooled and mixed may be incorporated with firmly beaten egg white and then cooled and stirred further.

[0095] Moreover, the process described in Claim 16 may be modified such that the sherbet mix is incorporated with alcohol, as defined in Claim 17.

[0096] The first aspect of the present invention offers the erythritol-containing soft sherbet which has a much lower calorific value than the conventional sherbet containing sucrose or high fructose corn syrup and hence is useful as a dietetic food. Particularly, the sherbet containing erythritol alone as a sweetener is acceptable to patients with derangement of carbohydrate metabolism who are not allowed to take sweeteners such as sucrose and glucose, because it has a lower calorific value (by more than 90%) as compared with the conventional sherbet.

[0097] Unlike the conventional sherbet containing citrus juice (lemon or orange) which has an unpleasant after taste due to sweetener of sucrose or the like and fruit juice, the erythritol-containing sherbet was found to have a preferable effect of giving a refreshing after taste because the non-lasting sweetness of erythritol rapidly drowns the unpleasant taste of juice.

(The second aspect of the invention)

[0098] What follows is a detailed description of the second aspect of the present invention.

[0099] The second aspect of the present invention is intended to provide an erythritol-containing alcoholic soft sherbet which will be served as a soft ice-like frozen alcoholic beverages and a process for producing the same, and also to provide an aqueous solution as a raw material from which the erythritol-containing alcoholic soft sherbet is made.

[0100] The erythritol-containing alcoholic soft sherbet as defined in Claim 18 according to the second aspect of the present invention is a modified product of the sherbet defined in Claim 1, which contains alcohol and the amount of alcohol contained is not less than 1 vol% and not more than 18 vol%.

[0101] The erythritol-containing alcoholic soft sherbet according to the second aspect of the present invention is served as a soft ice-like frozen alcoholic beverage. It does not flow but gives a soft ice-like mouthfeel. The term "soft ice-like" means that the frozen alcoholic beverage is in an inhomogeneous state, with ice crystals and concentrated

solution (formed by freezing) being mixed together. Thus the soft ice-like frozen alcoholic beverage can be easily spooned, with grains not so coarse as chipped ice and not so fine as ice cream.

[0102] "Soft ice-like" may be numerically expressed as having a freeze hardness (at -20°C) not less than 150 g and less than 1000 g measured with a rheometer.

[0103] Specifically, the freeze hardness is measured with a rheometer by pushing a conical tip (10 mm high, 10 mm in bottom diameter) into a cylindrical frozen sample of the alcoholic beverage (25 mm high, 25 mm in diameter) at a certain speed (1 mm/min) and is expressed in terms of the maximum stress required for the tip to penetrate into the sample. If the maximum stress is not less than 150 g and less than 1000 g, the sample is said herein the present invention to be "soft ice-like". Values not less than 500 g and less than 1000 g are preferable, and values not less than 150 g and less than 500 g are particularly preferable.

[0104] The erythritol-containing alcoholic soft sherbet according to the second aspect of the present invention contains alcohol in the form of any known alcoholic beverages, such as whisky, wine, brandy, gin, vodka, tequila, rum (white rum), liqueur, their cocktails, "sake", and "shochu".

[0105] Next, the erythritol-containing alcoholic soft sherbet according to the second aspect of the present invention contains at least erythritol as sugar alcohol which functions as saccharide.

[0106] The sugar alcohol includes, in addition to erythritol, xylitol, glycerin, sorbitol, mannitol, multitol, lactitol, palatinit, and hydrogenated glucose syrup, as mentioned in the first aspect of the present invention.

[0107] These sugar alcohols have a lower calorific value than sucrose, which helps the soft ice-like frozen alcoholic beverage to have a low calorific value. Of these sugar alcohols, erythritol is selected and used alone or in combination with xylitol because of its low molecular weight and good taste, although other sugar alcohols may also be used according to need.

[0108] The calorific values of these sugar alcohols have been given in the first aspect of the present invention.

[0109] These sugar alcohols are commercially available, and their sources are not specifically restricted. They may be used as it is in the form of either solid (crystals, granules, and fine powder) or liquid.

[0110] Erythritol is a polyol with four carbon atoms and a molecular weight of 122. Its sweetness is 80% of that of sucrose. Its molecular weight is much lower than that of sucrose (342), which lowers the freezing point to a great extent. Therefore, the extent to which it lowers the freezing point is much greater than that of sucrose for the same sweetness and sugar content.

[0111] On the other hand, xylitol is a polyol with five carbon atoms and a molecular weight of 152. It is as sweet as sucrose. Therefore, the freezing point of xylitol is much greater than that of sucrose for the same saccharide concentration.

[0112] Xylitol has a eutectic point at a considerably lower temperature and a considerably higher concentration than other polyols and sugars. Therefore, it is stable in its frozen state. Upon freezing, it leaves a concentrated solution having a low viscosity, which also contributes to the low freeze hardness.

[0113] For this reason, erythritol used alone or in combination with xylitol lowers the freezing point without increasing the sweetness and saccharide concentration. This leads to a reduction in freeze hardness. Thus obtained is the erythritol-containing alcoholic soft sherbet or the soft ice-like frozen alcoholic beverage.

[0114] Incidentally, glycerin also has the freeze control action similar to erythritol or xylitol, but its use should be limited to such an extent that it does not aggravate taste and does not increase calorific value.

[0115] Another adequate additive is sorbitol. It has a molecular weight of 182, which is slightly higher than that of erythritol and xylitol but lower than sucrose. As compared with sucrose, it is less sweet and lower in crystallizability, for which sorbitor is adequate as additives.

[0116] Erythritol and xylitol are as palatable as sucrose and other sugars and is free from after taste.

[0117] Thus, the frozen alcoholic beverage containing erythritol alone or in combination with xylitol without containing sugar has a low level of calorific value, with its sweetness quality unchanged. (See Claims 21 and 22.)

[0118] Similarly to non-sugar sweeteners, these sugar alcohols permit the production of an erythritol-containing alcoholic soft sherbet or soft ice-like frozen alcoholic beverage which is non-cariogenic and low in calorific value.

[0119] Incidentally, the erythritol-containing alcoholic soft sherbet according to the second aspect of the present invention may contain, in addition to the above-mentioned sugar alcohols, a variety of sugars or non-sugar sweeteners. Owing to such sugars or non-sugar sweeteners, the soft sherbet to be served as a frozen alcoholic beverage may have its sweetness enhanced or lessened as desired or may have its sweetness quality improved or controlled.

[0120] Examples of the sugar include sucrose, glucose, high fructose corn syrup, trehalose, and starch syrup.

[0121] Examples of the non-sugar sweeteners include aspartame, acesulfam K, stevia, dihydrochalcones, and thaumatin. These non-sugar sweeteners are used so that the soft sherbet or soft ice-like frozen alcoholic beverage is non-cariogenic and low in calorific value.

[0122] The erythritol-containing alcoholic soft sherbet as defined in Claim 18 basically contains the above-mentioned components, with alcohol in an amount not less than 1 vol% and not more than 18 vol% and with at least erythritol as the sugar alcohol. With an alcohol concentration exceeding 18 vol%, the soft sherbet (the erythritol containing alcoholic

soft sherbet according to the second aspect of the present invention defined in Claim 18, and served as a soft ice-like frozen alcoholic beverage) does not freeze sufficiently, and this makes it necessary to maintain the freezing temperature very low so that the soft sherbet has a mouthfeel resembling that of soft ice as desired.

[0123] The sherbet of the present invention defined in Claim 18 contains saccharide in a total amount not more than 30 wt% as defined in Claim 19.

[0124] In case where alcohol concentration is as low as 1 vol%, for example, it is possible to obtain a soft sherbet or soft-ice like frozen alcoholic beverage with saccharide in an amount of 55 wt%. The saccharide content of 55 wt% is too sweet to taste even though the sugar alcohol is less sweet than sucrose and other sugars. Therefore, preferable total amount of saccharide is 30 wt% or less as defined in Claim 19.

[0125] In general, with an alcohol concentration more than 8 vol%, the sherbet is less palatable (due to high alcohol concentration) than the ordinary cocktails which are served without freezing. With an alcohol concentration less than 4 vol%, the sherbet is high in freeze hardness and lacks the mouthfeel resembling that of soft ice. Therefore, the preferred alcohol concentration is 4-8 vol% and the total sugar content corresponding to this alcohol concentration is 15-25 wt%.

[0126] Incidentally, the alcohol concentration can be adjusted by adding water to the predetermined concentration.

[0127] The desired alcohol concentration and the total saccharide amount corresponding to it are defined in Claim 20.

[0128] That is, according to Claim 20, the soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage contains 4-8 vol% alcohol and also contains erythritol as at least one of sugar alcohols, with the total amount of saccharide being 15-25 wt%.

[0129] In the erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the invention, most preferable total amount of saccharide depends on the alcohol concentration. If the alcohol concentration is low, in order that the frozen alcoholic beverage maintains a freeze hardness in the range of 150 g to 1000 g, the saccharide concentration may be rather high. Conversely, if the alcohol concentration is high, the saccharide concentration should be low.

[0130] Consequently, according to claim 21, the erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage of the present invention contains alcohol in an amount of 4-6 vol%, erythritol in an amount not less than 1 wt% and less than 10 wt%, and xylitol in an amount of 0-23 wt%, with the total saccharide amount being 20-25 wt%.

[0131] By contrast, the total saccharide amount is less than this if the alcohol concentration exceeds 6 vol%, as defined in Claim 22.

[0132] That is, according to Claim 22, in the erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage of the present invention the amount of alcohol contained is over 6 vol% and not more than 8 vol%, the amount of erythritol not less than 1 wt% and less than 10 wt%, and the amount of xylitol 0-20 wt%, with the total saccharide amount being 15-20 wt%.

[0133] In other words, the content of erythritol should be not less than 1 wt% and less than 10 wt%. An amount less than 1 wt% leads to insufficient freeze hardness and an amount of 10 wt% or above leads to crystallization in the product. Thus, both cases are undesirable.

[0134] Next, the content of xylitol varies in its upper limit depending on the alcohol concentration.

[0135] That is, xylitol is contained in an amount of 0-23 wt% when the alcohol concentration is 4-6 vol%, or in an amount of 0-20 wt% when the alcohol concentration is over 6 vol% and not more than 8 vol%. The xylitol content exceeding the upper limit results in an excessively sweet, thus undesirable product.

[0136] Incidentally, the total saccharide content also varies depending on the alcohol concentration. It is 20-25 wt% when the alcohol concentration is 4-6 vol%, and it is 15-20 wt% when the alcohol concentration is over 6 vol% and not more than 8 vol%.

[0137] The reason for this is that a slightly high saccharide concentration is acceptable for a low alcohol concentration, whereas a lower saccharide concentration is necessary for a high alcohol concentration, as mentioned above.

[0138] With a total saccharide content less than the above-mentioned lower limit, the resulting product has a rough mouthfeel due to excessively grown ice crystals. By contrast, with a total saccharide content more than the above-mentioned upper limit, the resulting product is excessively sweet. Both cases are undesirable.

[0139] The erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention may additionally contain a thickening stabilizer as defined in Claim 23. The thickening stabilizer may be in the form of powder, solid, or whatever. Any commercial one may be used.

[0140] The thickening stabilizer that can be used in the present invention as defined in Claim 23 may be any one which is ordinarily used in the food industry. Particularly, desirable is one or more species selected from the group consisting of xanthane gum, carrageenan, guar gum, locust bean gum, tamarind gum, and gum arabic.

[0141] These thickening stabilizers impart an adequate viscosity to the product, regulate the size of ice crystals, thereby forming agglomerated ice, and help the entire frozen layers to freeze uniformly. In addition, they keep the product in its soft ice state for a long time after it has been taken out of the freezer.

[0142] The erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage defined in Claim 23 according to the present invention may contain a thickening stabilizer in an amount of 0.02-0.15 wt%, preferably 0.05-0.1 wt%.

[0143] With an amount less than 0.02 wt%, the thickening stabilizer does not produce its effect. With an amount more than 0.15 wt%, the thickening stabilizer unpreferably renders the product excessively viscous.

[0144] The erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention contains an alcoholic ingredient, erythritol (or erythritol in combination with xylitol), a thickening stabilizer, and an optional saccharide other than erythritol and xylitol. It may further optionally contain another food component and food additive component such as fruit juice, flavors, food colors, and acidulant (including citric acid, malic acid, and tartaric acid) in an amount not harmful to the object of the present invention.

[0145] Of these components, juice is desirable because it imparts an adequate taste and flavor to the alcoholic beverage. Therefore, usually juice is incorporated into the product.

[0146] Juice of any kind can be used without specific restrictions. Examples include those of citrus fruits (such as lime, lemon, orange, "yuzu", and "kabosu"), pineapple, apple, grape, and vegetables (such as tomato). Their concentrated or powdered juice is also acceptable.

[0147] The erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention may be incorporated with juice in an amount of about 4 vol%, preferably 0.5-5 vol%. With an amount less than 0.5 vol%, the juice gives no flavor desired. With an amount more than 5 vol%, the juice gives flavor excessively and lowers the freezing point.

[0148] The above-mentioned erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention can be easily made by stirring and mixing the above-mentioned components as raw materials and simply freezing the resulting mixture, without stirring and whipping air into syrup, in the freezing compartment of a home refrigerator or a refrigerated warehouse in the convenience store or the like, because it has a high alcohol concentration.

[0149] The above-mentioned erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention is produced by the process explained below.

[0150] As defined in Claims 24 to 27, the process consists of stirring and mixing an alcoholic ingredient, erythritol or a mixture of erythritol and xylitol, an optional saccharide other than erythritol and xylitol, and a thickening stabilizer, and then freezing the resulting mixture.

[0151] The mixing ratio is described in Claims 18 to 23 covering the sherbet. The freezing may be accomplished usually at temperatures in the range of -15°C to -20°C for 7 to 20 hours, although these conditions are not specifically restricted.

[0152] The erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage according to the second aspect of the present invention should preferably undergo heat sterilization after packaging into an adequate container and sealing.

[0153] Moreover, Claims 28 to 31 cover a solution as a raw material from which the sherbet is made, the solution comprising an alcoholic ingredient, erythritol or a mixture of erythritol and xylitol, an optional saccharide other than erythritol and xylitol, and a thickening stabilizer. Specific description on each component has been made in the above.

[0154] The solution as a raw material for sherbet production as defined in Claims 28 to 31 may be distributed as such in the form of solution as a raw material for sherbet production and made into the erythritol-containing alcoholic soft sherbet or the erythritol-containing soft ice-like frozen alcoholic beverage as defined in Claims 18 to 23 according to the second aspect of the present invention by simply freezing in the freezing compartment of a home refrigerator or a refrigerated warehouse in the convenience store or the like.

Examples

[0155] In what follows, the invention will be described in more detail with reference to Examples and Comparative Examples, which are not intended to restrict the scope of the invention. (Examples according to the first aspect of the invention)

Examples 1 to 10

[0156] In 365 ml of water was dissolved 100 g of erythritol (from Nikken Chemicals Co., Ltd.). In 50 ml of boiling water was dissolved gelatin (from Maruha Co., Ltd.) as a foam stabilizer in a varied amount from 2.0 g to 5.0 g as shown in Table 1. To the erythritol solution were added the gelatin solution, 75 ml of lemon juice, and 10 ml of liqueur (trade name: "Cointreau" containing 40 vol% alcohol, from Remy Japon Co., Ltd.). Thus there was obtained 500 ml of sherbet mix (having a freezing point of -3.5°C). This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which

had previously been cooled to -20°C in a freezer and then stirred therein until ice crystals crystallized, with overrun adjusted to about 70% to 110% as shown in Table 1. During this process, the temperature of the sherbet mix was -6°C. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there was obtained the sherbet. Table 1 shows the processing conditions and results.

Comparative Example 1

[0157] The same raw materials as in Example 1 were used except that the erythritol was replaced by sucrose, the gelatin solution was replaced by 50 ml of water, and the same procedure as in Example 1 was repeated except that the overrun was reduced to 25%, and the sherbet was made. Table 1 shows the processing conditions and results.

Table 1

	Example No.										Comparative Example 1
	1	2	3	4	5	6	7	8	9	10	
Overrun (%)	110	110	90	90	90	80	80	80	70	70	25
Gelatin (g)	5.0	2.0	5.0	3.0	2.0	5.0	4.0	3.0	5.0	4.0	4.0
(w/v %)	1.0	0.4	1.0	0.6	0.4	1.0	0.8	0.6	1.0	0.8	0.8
Calorie (kcal/100 ml)	3.0	3.0	3.0	3.3	3.3	3.4	3.4	3.4	3.7	3.7	69.0
Evaluation *	○	○	○	○	○	○	○	△	○	△	○

*
○ : soft to be scooped
△ : slightly hard to be scooped
X : too hard to be scooped

[0158] It is shown in Table 1 that the sherbet according to the first aspect of the present invention is superior in storage stability, retaining its soft mouthfeel for 3 months in the freezer at -20°C, and is much lower in calorific value as compared with the sucrose-containing sherbet in Comparative Example 1.

Example 11

[0159] In 360 ml of water was dissolved 100 g of erythritol (from Nikken Chemicals Co., Ltd.). In 50 ml of boiling water was dissolved 5.0 g of gelatin (from Maruha Co., Ltd.) as a foam stabilizer. To the erythritol solution were added the gelatin solution, 75 ml of lemon juice, and 15 ml of liqueur (trade name: "Maraschino" containing 30 vol% alcohol, from Suntory Co., Ltd.). Thus there was obtained 500 ml of sherbet mix (having a freezing point of -3.5°C). This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer and then stirred therein until ice crystals crystallized, with overrun adjusted to 100%. During this process, the temperature of the sherbet mix was -6°C. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there was obtained the sherbet which was easy to spoon and gave a soft mouthfeel.

Example 12

[0160] In 350 ml of black tea was dissolved 100 g of erythritol (from Nikken Chemicals Co., Ltd.). In 50 ml of boiling water was dissolved 4.0 g of gelatin (from Maruha Co., Ltd.) as a foam stabilizer. To the erythritol solution were added the gelatin solution, 10 ml of liqueur (trade name: "Cointreau" containing 40 vol% alcohol, from Remy Japon Co., Ltd.), and about 90 ml of water. Thus there was obtained 500 ml of sherbet mix. This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer and then stirred therein until ice crystals crystallized, with overrun adjusted to 85%. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there was obtained the sherbet with a flavor of black tea which was easy to spoon and gave a soft mouthfeel.

Example 13

[0161] In 265 ml of water was dissolved 100 g of erythritol (from Nikken Chemicals Co., Ltd.). In 150 ml of boiling water was dissolved 5 g (1 vol%) or 15 g (3 vol%) of pectin as a foam stabilizer. To the erythritol solution were added the pectin solution, 75 ml of lemon juice, and 10 ml of liqueur (trade name: "Cointreau" from Remy Japon Co., Ltd.). Thus there was obtained 500 ml of sherbet mix. This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer and then stirred therein until ice crystals crystallized. When overrun reached about 20%, the sherbet mix was incorporated with 60 g of firmly beaten egg white. Whipping air into syrup was continued until overrun reached 100%. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there were obtained two kinds of sherbet (with 5 g or 15 g of pectin) both of which were easy to spoon and gave a soft mouthfeel.

[0162] As mentioned above, the erythritol-containing sherbet according to the first aspect of the present invention gives a desirable soft mouthfeel as the result of its overrun of 50-130% although it contains erythritol as its sole sweetener.

Examples 14 to 20

[0163] In 160 ml of water and 150 ml of orange juice were dissolved erythritol (from Nikken Chemicals Co., Ltd.) and sucrose in an amount respectively shown in Table 2. To the resulting solution were added 10 ml of lemon juice and 8 ml of liqueur (trade name: "Cointreau" containing 40 vol% alcohol, from Remy Japon Co., Ltd.). Thus there was obtained a sherbet mix. This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer and then stirred therein to crystallize ice crystals until overrun reached about 40%. The frothed sherbet mix was incorporated with 30 g of firmly beaten egg white. Whipping air into syrup was continued until overrun reached 90%. The temperature of the sherbet mix at that time was -6°C. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there was obtained the sherbet. The results are shown in Table 2.

Example 21

[0164] In 160 ml of water and 150 ml of orange juice were dissolved erythritol (from Nikken Chemicals Co., Ltd.) and sucrose in an amount respectively shown in Table 2. To the resulting solution were added 10 ml of lemon juice and 8 ml of liqueur (trade name: "Cointreau" containing 40 vol% alcohol, from Remy Japon Co., Ltd.). Thus there was obtained a sherbet mix. This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer, 20 g of firmly beaten egg white was added thereto and the sherbet mix was stirred until ice crystals crystallized, with overrun adjusted to 60%. The temperature of the sherbet mix at that time was -6°C. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there were obtained the sherbet. The results are shown in Table 2.

Table 2

	Example No.							
	14	15	16	17	18	19	20	21
Total sugar content (w/v%)	23	17	17	13	13	11	11	13
Erythritol (g)	30	25	20	19	12.5	20	15	12.5
Sucrose (g)	30	15	20	6	12.5	0	5	12.5
Evaluation *	○	△	○	○	○	X	○	○

*
○ : soft to be scooped
△ : slightly hard to be scooped
X : too hard to be scooped

[0165] It is shown in Table 2 that the sherbet with egg white according to the first aspect of the present invention is superior in storage stability, retaining its soft mouthfeel for 3 months in the freezer at -20°C.

[0166] The sherbet in Example 21 which contains both erythritol and sucrose, though having an overrun of 60%, was soft to be scooped. The same result was obtained in Example 21 in which the sucrose was replaced by lactitol.

Example 22 and Comparative Example 2

[0167] The same procedure as in Example 14 was repeated to make a sherbet from a sherbet mix containing the same ingredients as in Example 17 and 0.65 g of emulsifier (sucrose fatty acid ester, trade name: "DK Ester F-160" from Dai-ichi Kogyo Seiyaku Co., Ltd.) and 1 g of foam stabilizer (a mixture of tamarind gum 80% and guar gum 20%, trade name: "Glyroid 2AG" from Dainippon Seiyaku Co., Ltd.).

[0168] In Comparative Example 2, the same procedure was repeated and the same ingredients were used as in Example 21 to produce a sherbet except that no egg white was added.

[0169] The sherbet in Example 22 (which was incorporated with an emulsifier and foam stabilizer) gave a soft mouthfeel even immediately after taken out of the freezer, whereas the sherbet in Comparative Example 2 (which was not incorporated with egg white) was too hard to be scooped for a while after taken out of the freezer and thus was not able to be eaten.

Examples 23 and 24 and comparative Example 3

[0170] In 320 ml of water were dissolved eryhhritol (from Nikken Chemicals Co., Ltd.), sucrose, lactitol (from Nikken Chemicals Co., Ltd.), and polydextrose (from Pfizer Co., Ltd.) in varied amounts as shown in Table 3. To the resulting solution were added 8 ml of liqueur (trade name: "Cointreau" containing 40 vol% alcohol, from Remy Japon Co., Ltd.), 0.65 g of emulsifier (sucrose fatty acid ester, trade name: "DK Ester F-160 (HLB 15)" from Dai-ichi Kogyo Seiyaku Co., Ltd.), and 1 g of foam stabilizer (a mixture of tamarind gum 80% and guar gum 20%, trade name: "Glyroid 2AG" from Dainippon Seiyaku Co., Ltd.). Thus there was obtained a sherbet mix. This sherbet mix was put in an electric ice cream maker (from Ismet Co., Ltd.) which had previously been cooled to -20°C in a freezer and then stirred therein until ice crystals crystallized, with overrun adjusted to about 40%. The frothed sherbet mix was incorporated with 30 g of firmly beaten egg white. The overrun of the sherbet mix was 90% and the temperature was -6°C. Then, the sherbet mix was put in cups and solidified at -20°C. Thus there was obtained the sherbet. The results are shown in Table 3.

Table 3

	Example No.		Comparative Example No.
	23	24	3
Erythritol (g)	18	18	0
Lactitol (g)	22	0	0
Polydexdrose (g)	0	22	0
Sucrose (g)	0	0	40
Calorific value (kcal/100 ml)	13.9	9.4	37.5
Evaluation *	○	○	○

*

○ : soft to be scooped

△ : slightly hard to be scooped

X : too hard to be scooped

[0171] It is noted from Table 3 that the erythritol-containing sherbet with egg white (in Examples 23 and 24) according to the first aspect of the present invention is much lower in calorific value than the sherbet using sucrose in Comparative Example 3.

[0172] The foregoing indicates that the erythritol-containing sherbet according to the first aspect of the present invention has a low calorific value and gives a soft mouthfeel because it contains erythritol as a sweetener, with part of it replaced by any other component, so that it decreases in freeze hardness.

(Examples according to the second aspect of the invention)

Experiment Example 1

[0173] In a fixed amount of water were dissolved white rum (as an alcoholic ingredient, in alcohol concentration of 4

vol% or 6 vol%), high fructose corn syrup, and erythritol (from Nikken Chemicals Co., Ltd.) in a varied ratio as shown in Table 4. The solution was stirred and mixed together with xanthane gum (0.08 wt%) and lemon juice (4 vol%) and then frozen in a freezer at -20°C for 9 hours. Thus there was obtained an erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage (frozen cocktail "daiquiri"). Incidentally, this soft sherbet contains high fructose corn syrup since an ordinary frozen cocktail uses high fructose corn syrup, which is as sweet as sucrose, and readily lowers freeze hardness.

[0174] Evaluations on freeze hardness and observation results of the thus obtained frozen alcoholic beverage are shown in Table 4. In Table 4, the alcoholic ingredient is expressed in terms of ethanol concentration.

Table 4 (Experiment Example 1)

Run No.	Alcohol concentration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol (%)	Freeze hardness	Remarks
1-1	4	15	15	0	X	
1-2	4	15	10	5	X	
1-3	4	15	8	7	X	
1-4	4	15	6	9	X	
1-5	4	15	5	10	X	Crystallized
2-1	4	20	20	0	X	
2-2	4	20	19	1	△	
2-3	4	20	17	3	○	
2-4	4	20	15	5	○	
2-5	4	20	13	7	○	
2-6	4	20	11	9	○	
2-7	4	20	10	10	○	Crystallized
3-1	4	25	25	0	○	Too sweet
3-2	4	25	24	1	○	Rather oversweet
3-3	4	25	22	3	○	
3-4	4	25	20	5	○	
3-5	4	25	18	7	○	
3-6	4	25	16	9	○	
3-7	4	25	15	10	○	Crystallized
4-1	4	30	30	0	○	Too sweet
5-1	6	15	15	0	X	
5-2	6	15	10	5	X	
5-3	6	15	8	7	X	
5-4	6	15	6	9	X	
5-5	6	15	5	10	X	Crystallized
6-1	6	20	20	0	△	
6-2	6	20	19	1	△	
6-3	6	20	17	3	○	
6-4	6	20	15	5	○	
6-5	6	20	13	7	○	
6-6	6	20	11	9	○	
6-7	6	20	10	10	○	Crystallized
7-1	6	25	25	0	△	Too sweet
7-2	6	25	24	1	△	Rather oversweet
7-3	6	25	22	3	○	
7-4	6	25	20	5	◎	
7-5	6	25	18	7	◎	
7-6	6	25	16	9	○	
7-7	6	25	15	10	○	Crystallized
8-1	6	30	30	0	◎	Too sweet

Evaluations:

◎ : in particularly good state, with freeze hardness not less than 1500 g and less than 500 g.

○ : in good state, with freeze hardness not less than 500 g and less than 1000 g.

△ : in slightly good state, with freeze hardness not less than 1000 g and less than 1500 g.

X : in poor state, with freeze hardness not less than 1500 g.

[0175] It is noted from Table 4 that the resulting soft ice-like frozen alcoholic beverage has moderate sweetness and preferable freeze hardness (with erythritol not crystallized) if the concentration of alcohol is 4-6 vol%, the content of erythritol is 3-7 wt%, and the total amount of saccharides is 20-25 wt%.

[0176] It is also noted from Table 4 that such a soft ice-like frozen alcoholic beverage cannot be obtained if high fructose corn syrup is used alone. In addition, it is noted that the resulting product is turbid to have undesired properties due to crystallization when it contains erythritol in an amount of 10 wt%.

Experiment Example 2

[0177] In a fixed amount of water were dissolved white rum (as an alcoholic ingredient, in alcohol concentration of 7 vol% or 8 vol%), high fructose corn syrup, and erythritol (from Nikken Chemicals Co., Ltd.) in a varied ratio as shown in Table 5. The solution was stirred and mixed together with xanthane gum (0.08 wt%) and lemon juice (4 vol%) and then frozen in a freezer at -20°C for 9 hours. Thus there was obtained a frozen alcoholic beverage (frozen cocktail "Daiquiri").

[0178] Evaluations on freeze hardness and observation results of the thus obtained frozen alcoholic beverage are shown in Table 5. In Table 5, the alcoholic ingredient is expressed in terms of ethanol concentration contained generally in drink. Freeze hardness was evaluated in the similar method as shown in remarks of Table 4.

Table 5

(Experiment Example 2)						
Run No.	Alcohol concentration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol(%)	Freeze hardness	Remarks
1-1	7	15	15	0	△	
1-2	7	15	14	1	△	
1-3	7	15	12	3	○	
1-4	7	15	10	5	○	
1-5	7	15	8	7	○	
1-6	7	15	6	9	○	
1-7	7	15	5	10	○	Crystallized
2-1	7	20	20	0	△	
2-2	7	20	19	1	△	
2-3	7	20	17	3	○	
2-4	7	20	15	5	◎	
2-5	7	20	13	7	◎	
2-6	7	20	11	9	◎	
2-7	7	20	10	10	○	Crystallized
3-1	7	25	25	0	◎	Too sweet
4-1	8	15	15	0	△	
4-2	8	15	14	1	△	
4-3	8	15	12	3	○	
4-4	8	15	10	5	○	
4-5	8	15	8	7	◎	
4-6	8	15	6	9	◎	
4-7	8	15	5	10	○	Crystallized
5-1	8	20	20	0	△	
5-2	8	20	19	1	△	

Table 5 (continued)

(Experiment Example 2)						
Run No.	Alcohol concentration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol(%)	Freeze hardness	Remarks
5-3	8	20	17	3	◎	
5-4	8	20	15	5	◎	
5-5	8	20	13	7	◎	
5-6	8	20	11	9	◎	Crystallized
5-7	8	20	10	10	○	Crystallized
6-1	8	25	25	0	◎	Too sweet

[0179] It is noted from Table 5 that the erythritol-containing alcoholic soft sherbet or soft ice-like frozen alcoholic beverage has moderate sweetness and desirable freeze hardness (with erythritol not crystallized) if the alcohol concentration is over 6 vol% and not more than 8 vol%, the content of erythritol is not less than 1 wt% and less than 10 wt%, and the total amount of saccharides is in the range of 15-20 wt%.

[0180] It is also noted that as compared with the results (Table 4) of Experiment Example 1 in which the alcohol concentration is 4-6 vol%, if the alcohol concentration is high, although the same amount of erythritol is required, it is enough that the amount thereof is less than the total amount of saccharides.

Experiment Example 3

[0181] In a fixed amount of water were dissolved tequila (as an alcoholic ingredient, in an alcohol concentration of 4 vol% or 6 vol%), high fructose corn syrup, erythritol (from Nikken Chemicals Co., Ltd.), and xylitol (from Nikken Chemicals Co., Ltd.) in a varied ratio as shown in Table 6. The solution was stirred and mixed together with carrageenan (0.08 wt%) and lemon juice (4 vol%) and then frozen in a freezer at -20°C for 9 hours. Thus there was obtained erythritol-containing alcoholic soft sherbet or a frozen alcoholic beverage (frozen cocktail "Margarita").

[0182] Evaluations on freeze hardness and observation results of the thus obtained frozen alcoholic beverage are shown in Table 6. In Table 6, the alcoholic ingredient is expressed in terms of ethanol concentration contained generally in drink. Freeze hardness was evaluated in the similar method as shown in remarks of Table 4.

Table 6 (Experiment Example 3)

Run No.	Alcohol concen-tration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol (%)	Xylitol (%)	Freeze Hardness	Observation
1-1	4	20	17	3	0	○	
1-2	4	20	0	3	17	○	
1-3	4	20	15	5	0	○	
1-4	4	20	0	5	15	○	
1-5	4	20	0	7	13	○	
1-6	4	20	13	7	0	○	
1-7	4	18	0	7	11	△	
1-8	4	20	11	9	0	○	
1-9	4	20	0	9	11	○	
1-10	4	25	24	1	0	○	Rather oversweet
1-11	4	25	0	1	24	○	Rather oversweet
1-12	4	25	22	3	0	○	
1-13	4	25	0	3	22	○	
1-14	4	25	20	5	0	○	
1-15	4	21	0	5	16	○	
1-16	4	25	18	7	0	○	
1-17	4	21	0	7	14	○	
1-18	4	25	16	9	0	○	
1-19	4	21	0	9	12	○	
2-1	6	25	24	1	0	○	Rather oversweet
2-2	6	25	0	1	24	◎	Rather oversweet
2-3	6	25	22	3	0	◎	
2-4	6	21	0	3	18	◎	
2-5	6	25	20	5	0	◎	
2-6	6	21	0	5	16	◎	
2-7	6	25	18	7	0	◎	
2-8	6	21	0	7	14	◎	
2-9	6	25	16	9	0	◎	
2-10	6	21	0	9	2	◎	

[0183] It is noted from Table 6 that the erythritol-containing alcoholic soft sherbet or soft ice-like frozen alcoholic beverage has moderate sweetness and desirable freeze hardness (with erythritol not crystallized) if the alcohol concentration is 4-6 vol%, the content of erythritol is 3-7 wt%, and the total amount of saccharides is 20-25 wt%. The amount of xylitol to be used in combination with erythritol should be 4-23 wt%.

[0184] It is also noted that the erythritol-containing alcoholic soft sherbet or soft ice-like frozen alcoholic beverage has good properties if it contains erythritol, or erythritol and xylitol even though it does not contain saccharides. This suggests the possibility of sugarless formulations.

Experiment Example 4

[0185] In a fixed amount of water were dissolved tequila (as an alcoholic ingredient, in an alcohol concentration of 7 vol% or 8 vol%), high fructose corn syrup, erythritol (from Nikken Chemicals Co., Ltd.), and xylitol (from Nikken Chemicals Co., Ltd.) in a varied ratio as shown in Table 7. The solution was stirred and mixed together with carrageenan (0.06 wt%) and lemon juice (4 vol%) and then frozen in a freezer at -20°C for 9 hours. Thus there was obtained erythritol-containing alcoholic soft sherbet or a frozen alcoholic beverage (frozen cocktail "Margarita").

[0186] Evaluations on freeze hardness and observation results of the thus obtained frozen alcoholic beverage are shown in Table 7. In Table 7, the alcoholic ingredient is expressed in terms of ethanol concentration contained generally in drink. Freeze hardness was evaluated in the similar method as shown in remarks of Table 4.

Table 7 (Experiment Example 4)

Run No.	Alcohol concentration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol (%)	Xylitol (%)	Freeze Hardness	Observations
1-1	7	15	12	3	0	○	
1-2	7	15	0	3	12	○	
1-3	7	15	10	5	0	○	
1-4	7	13	0	5	8	△	
1-5	7	15	8	7	0	○	
1-6	7	13	0	7	6	△	
1-7	7	15	6	9	0	○	
1-8	7	20	19	1	0	○	
1-9	7	20	0	1	19	○	
1-10	7	20	17	3	0	○	
1-11	7	17	0	3	14	○	
1-12	7	20	15	5	0	○	
1-13	7	17	0	5	12	○	
1-14	7	20	13	7	0	◎	
1-15	7	17	0	7	10	◎	
1-16	7	20	11	9	0	○	
1-17	7	17	0	9	8	◎	
2-1	8	15	12	3	0	○	
2-2	8	15	0	3	12	○	
2-3	8	20	19	1	0	○	
2-4	8	20	0	1	19	◎	
2-5	8	20	17	3	0	◎	
2-6	8	17	0	3	14	◎	
2-7	8	20	15	5	0	◎	
2-8	8	17	0	5	12	◎	
2-9	8	20	13	7	0	◎	
2-10	8	17	0	7	10	◎	
2-11	8	20	11	9	0	◎	
2-12	8	17	0	9	8	◎	

[0187] It is noted from Table 7 that the erythritol-containing alcoholic soft sherbet or soft ice-like frozen alcoholic beverage has moderate sweetness and desirable freeze hardness (with erythritol not crystallized) if the alcohol concentration is over 6 vol% and not more than 8 vol% under the following condition.

[0188] That is, the content of erythritol is not less than 1 wt% and less than 10 wt% (without xylitol) and the total amount of saccharides is 15-20 wt%, or the content of erythritol is not less than 1 wt% and less than 10 wt%, the content of xylitol is 4-20 wt%, and the total amount of saccharides is 15-20 wt%. When these conditions are fulfilled, the objective erythritol-containing alcoholic soft sherbet or soft-ice like frozen alcoholic beverage is obtained.

Experiment Example 5

[0189] In a fixed amount of water were dissolved white rum (as an alcoholic ingredient, in an alcohol concentration of 6 vol% or 8 vol%), 15 wt% of high fructose corn syrup, 5 wt% of erythritol (from Nikken Chemicals Co., Ltd.), 4 vol% of lemon juice, and carrageenan or xanthane gum (as a thickening stabilizer) in a varied ratio as shown in Table 8. The solution was stirred and mixed, and frozen in a freezer at -20°C for 9 hours. Thus there was obtained an erythritol-containing alcoholic soft sherbet or a frozen alcoholic beverage (frozen cocktail).

[0190] Evaluations on freeze hardness and observation results of the thus obtained frozen alcoholic beverage are shown in Table 8. In Table 8, the alcoholic ingredient is expressed in terms of ethanol concentration contained generally in drink. The evaluation of freeze hardness was based on a scale of three states according to the following criteria.

○ : small variation
△ : large variation
X : excessively high viscosity due to thickening stabilizer

Table 8

(Experiment Example 5)					
Run-No.	Alcohol concentration	Thickening stabilizer (%)		Freeze hardness	
		Name	Amount(%)	g	Evaluation
1-1	6	Carrageenan	0	220~800	△
1-2	6	-ditto-	0.01	200~600	△
1-3	6	-ditto-	0.02	190~370	○
1-4	6	-ditto-	0.05	170~330	○
1-5	6	-ditto-	0.08	200~350	○
1-6	6	-ditto-	0.1	180~360	○
1-7	6	-ditto-	0.15	200~370	○
1-8	6	-ditto-	0.2	viscous	X
1-9	8	-ditto-	0	80~600	△
1-10	8	-ditto-	0.01	100~530	△
1-11	8	-ditto-	0.02	120~280	○
1-12	8	-ditto-	0.05	90~260	○
1-13	8	-ditto-	0.08	100~250	○
1-14	8	-ditto-	0.1	130~300	○
1-15	8	-ditto-	0.15	120~280	○
1-16	8	-ditto-	0.2	too viscous	X
2-1	6	Xanthane gum	0	220~800	△
2-2	6	-ditto-	0.01	190~550	△
2-3	6	-ditto-	0.02	180~340	○
2-4	6	-ditto-	0.05	160-350	○
2-5	6	-ditto-	0.08	150~350	○
2-6	6	-ditto-	0.1	180~360	○
2-7	6	-ditto-	0.15	170~380	○
2-8	6	-ditto-	0.2	too viscous	X

[0191] It is noted from Table 8 that the thickening stabilizer added in an amount of 0.02-0.15 wt% contributes to the desired freeze hardness.

Experiment Example 6

[0192] In a fixed amount of water were dissolved white rum (as an alcoholic ingredient, in an alcoholic concentration of 8 vol%), 15 wt% of high fructose corn syrup, 5 wt% of erythritol (from Nikken Chemicals Co., Ltd.), 4 vol% of lemon juice, and 0.08 wt% of any one of guar gum, locust bean gum, and tamarind gum (as a thickening stabilizer). After stirring and mixing, the solution was frozen in a freezer at -20°C for 9 hours. Thus there was obtained an erythritol-containing alcoholic soft sherbet or a frozen alcoholic beverage (frozen cocktail).

[0193] The thus obtained erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage was found to have freeze hardness of 100-300 g.

[0194] It is apparent that gums such as guar gum, locust bean gum, and tamarind gum also contribute to freeze stabilization.

Experiment Example 7

[0195] Of the erythritol-containing alcoholic soft sherbets or soft ice-like frozen alcoholic beverage obtained in Experiment Examples 1 to 6 according to the present invention, some typical ones were selected for measurement of their calorific values. The measured calorific values were compared with those of the samples which contain high fructose corn syrup alone as the saccharide to calculate reduction in calorific value. Reducing effect in calorific value by erythritol and xylitol was examined. The results are shown in Table 9.

[0196] The calorific value of each erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage was measured by summing up the calorific value of alcohol and the calorific value of saccharides.

[0197] The calorific value of alcohol was obtained from the formula below according to the Food Composition Table, version 4.

$$\text{Amount of alcohol (g)} = (0.794/\text{s.g. of product}) \times \text{alcohol concentration}$$

[0198] Calorific value of alcohol (g) was calculated by multiplying the obtained amount of alcohol (g) by 6.93 (conversion coefficient).

[0199] In the above calculations, the specific gravity of the product (erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage) is regarded as 1.0 for convenience although it exceeds 1.0 when the solution contains saccharides.

[0200] The results of calculations indicate that the calorific value is 22 kcal/100 g for 4 vol% alcohol, 33 kcal/100 g for 6 vol% alcohol, 38.5 kcal/100 g for 7 vol% alcohol, 44 kcal/100 g for 8 vol% alcohol, and 55 kcal/100 g for 10 vol% alcohol.

[0201] On the other hand, the calorific value of saccharides was calculated from their respective concentrations in each example assuming that the high fructose corn syrup has 4 kcal/g, erythritol has 0 kcal/g, and xylitol has 2 kcal/g.

Table 9 (Experiment Example 7)

Run No.	Alcohol concentration (%)	Total amount of saccharides (%)	High fructose corn syrup (%)	Erythritol (%)	Xylitol (%)	Calorific value (kcal)	Reduction (%)
1-1	4	15	15	0	0	82	—
1-2	4	15	6	9	0	46	44
1-3	4	20	20	0	0	102	—
1-4	4	20	11	9	0	66	35
1-5	4	20	0	9	11	44	57
2-1	6	15	15	0	0	93	—
2-2	6	15	6	9	0	57	39
2-3	6	20	20	0	0	113	—
2-4	6	20	11	9	0	77	32
3-1	7	15	15	0	0	98.5	—
3-2	7	15	6	9	0	62.5	36
3-3	7	17	0	0	0	106.5	—
3-4	7	17	0	9	8	54.5	51
3-5	7	20	20	0	0	118.5	—
3-6	7	20	11	9	0	825	30
4-1	8	15	15	0	0	104	—
4-2	8	15	6	9	0	68	35
4-3	8	17	17	0	0	112	—
4-4	8	17	0	9	8	60	46
4-5	8	20	20	0	0	124	—
4-6	8	20	0	1	19	82	34

[0202] It is noted from Table 9 that the frozen alcoholic beverage containing erythritol alone or in combination with xylitol is lower in calorific value by about 30-50% than those products containing high fructose corn syrup (which is commonly used for beverages) even if the total amount of saccharides therein is the same.

[0203] In other words, it has been proven that it is possible to make the calorific value low by using a lot of erythritol and/or xylitol as the sweetener of the erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage.

Comparative Experiment Example

[0204] For the purpose of comparison, four kinds of commercial frozen cocktails were examined for alcohol concentration, saccharide concentration, freeze hardness, and calorific value. The results are shown in Table 10. Calorific values in Table 10 were evaluated according to the same criteria as in Table 4.

Table 10

(Comparative Experiment Example)				
	Alcohol concentration(%)	Saccharide concentration (%)	Freeze hardness	Calorific value (kcal)
Sample No. 1 Sherbet dessert	4	17.3	X	91.2
Sample No. 2 Strawberry Daiquiri	8	27.3	◎	153.2
Sample No. 3 Melon Daiquiri	8	27.9	◎	155.6
Sample No. 4 Margarita	10	23.4	◎	148.6

[0205] The following is apparent from Table 10.

[0206] Sample No. 1 has an adequate alcohol concentration (4 vol%) but is poor in freeze hardness (no less than 1000 g). Samples Nos. 2 and 3 have an adequate alcohol concentration (8 vol%) and are good in freeze hardness but have an excessive sweetness because of the total saccharide concentration not less than 27%. Sample No. 4 is good in both saccharide concentration and freeze hardness but undesirably has an excessively high alcohol concentration of 10 vol%.

[0207] These commercial samples have a calorific value of about 150 kcal/g if their alcohol concentration is about 8 vol%. By contrast, the erythritol-containing alcoholic soft sherbet or frozen alcoholic beverage according to the present invention has a calorific value of 70-90 kcal/g if its alcohol concentration is about 8 vol%. The calorific value of the present invention is lower than that of the commercial one by about 40-50%.

[0208] Therefore, the erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage obtained in Experiment Examples according to the second aspect of the present invention is lower than those commercial products in calorific value, saccharide concentration, and sweetness although its freeze hardness is the same with or more than that of commercial products.

[0209] The erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage according to the second aspect of the present invention has low freeze hardness and is soft ice-like product.

[0210] The erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage according to the second aspect of the present invention retains its soft ice state for a while after it has been taken out of the freezer.

[0211] Also, the erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage according to the second aspect of the present invention has a lower calorific value compared with commercial products containing saccharides such as sucrose, because it is incorporated with erythritol which is a sugar alcohol having a low calorific value. Further, it will be available in the sugarless form to meet the demands of the times.

[0212] That is, the product has almost the same alcohol concentration (4-8 vol%) as commercial products, a lower calorific value, a lower sugar content, and a low degree of sweetness, and yet it has low freeze hardness and is soft ice-like product because it is incorporated with erythritol as a sugar alcohol.

[0213] Moreover, the process according to the second aspect of the present invention permits easy production of said erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage in the freezing compartment of a home refrigerator without necessity for complex steps. In other words, the process according to the second aspect of the present invention permits one to make the erythritol-containing alcoholic soft sherbet or erythritol-containing soft ice-like alcoholic beverage by simple ordinary freezing treatment.

Industrial Applicability

[0214] The present invention provides an erythritol-containing sherbet having a low calorific value and a soft mouthfeel and also provides a process for making it. Therefore, it is useful for the frozen confectionary industry.

Claims

1. A sherbet which contains erythritol and has a soft mouthfeel.

2. The sherbet as defined in Claim 1, characterized in that it contains erythritol and a foam stabilizer, and characterized in that the overrun is 50-130%.

3. The sherbet as defined in Claim 1, characterized in that it contains erythritol, a foam stabilizer, and at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose, and characterized in that the overrun is 50-130%.

4. The sherbet as defined in Claim 2, wherein the overrun is 60-110% and the foam stabilizer is gelatin or pectin.

5. The sherbet as defined in Claim 3, wherein the overrun is 60-110% and the foam stabilizer is gelatin or pectin.

6. The sherbet as defined in Claim 3, wherein the overrun is 50-90% and the foam stabilizer is egg white.

7. The sherbet as defined in Claim 5 or 6, wherein the sugar is sucrose.

8. The sherbet as defined in Claim 5 or 6, wherein the sugar alcohol is lactitol.

9. The sherbet as defined in Claim 5 or 6, wherein the content of erythritol is not less than 50 wt% and less than 100 wt% of the total amount of erythritol and at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose.

10. The sherbet as defined in any one of Claims 1 to 9, further comprising alcohol.

11. A process for producing sherbet, characterized by comprising: preparing a sherbet mix from water, erythritol, and gelatin or pectin as a foam stabilizer; and stirring it with cooling, thereby crystallizing ice crystals, while whipping air into syrup until the overrun reaches 60-110%.

12. The process for producing sherbet as defined in Claim 11, wherein the sherbet mix is further incorporated with at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose.

13. The process for producing sherbet as defined in Claim 11 or 12, wherein the sherbet mix is further incorporated with alcohol.

14. The process for producing sherbet as defined in any one of Claims 11 to 13, wherein the amount of gelatin is in the range of 0.4-1 vol% of the sherbet mix.

15. The process for producing sherbet as defined in any one of Claims 11 to 13, wherein the amount of pectin is in the range of 1-3 vol% of the sherbet mix.

16. A process for producing sherbet characterized by comprising: preparing a sherbet mix from water, erythritol, at least one member selected from the group consisting of sugar, sugar alcohol, and polydextrose, and egg white as a foam stabilizer; and stirring it with cooling, thereby crystallizing ice crystals, while whipping air into syrup until the overrun reaches 50-90%.

17. The process for producing sherbet as defined in Claim 16, wherein the sherbet mix is further incorporated with alcohol.

18. The sherbet as defined in Claim 1 which is an alcoholic sherbet containing alcohol in an amount not less than 1 vol% and not more than 18 vol%.

19. The sherbet as defined in Claim 18, wherein the total amount of saccharides is not more than 30 wt%.

20. A sherbet, comprising: alcohol in an amount of 4-8 vol%; and at least erythritol as a sugar alcohol, wherein the total amount of saccharides is 15-25 wt%.

21. A sherbet, comprising: alcohol in an amount of 4-8 vol%; erythritol in an amount not less than 1 wt%; and less than 10 wt% and xylitol in an amount of 0-23 wt%, wherein the total amount of saccharides is 20-25 wt%.

22. A sherbet, comprising: alcohol in an amount over 6 vol% and less than 8 vol%; erythritol in an amount not less than 1 wt% and less than 10 wt%; and xylitol in an amount of 0-20wt%, wherein the total amount of saccharides is 15-20 wt%.

23. The sherbet as defined in any one of Claims 18 to 22, comprising a thickening stabilizer in an amount of 0.02-0.15 wt%, said thickening stabilizer being at least one member selected from the group consisting of xanthane gum, carrageenan, guar gum, locust bean gum, tamarind gum, and gum arabic.

24. The process for the production of sherbet as defined in any one of Claims 18 to 23, characterized in that an alcoholic ingredient and erythritol alone or in combination with xylitol are stirred and mixed together and subsequently the resulting mixture is frozen.

25. The process for the production of sherbet as defined in any one of Claims 18 to 23, characterized in that an alcoholic ingredient, erythritol alone or in combination with xylitol, and a saccharide other than erythritol and xylitol are stirred and mixed together and subsequently the resulting mixture is frozen.

26. The process for the production of sherbet as defined in any one of Claims 18 to 23, characterized in that an alcoholic ingredient, erythritol alone or in combination with xylitol, a saccharide other than erythritol and xylitol, and a thickening stabilizer are stirred and mixed together, and subsequently the resulting mixture is frozen.

27. The process for the production of sherbet as defined in any one of Claims 18 to 23, characterized in that an alcoholic ingredient, erythritol alone or in combination with xylitol, and a thickening stabilizer are stirred and mixed together, and subsequently the resulting mixture is frozen.

28. A solution as a raw material from which the sherbet defined in any one of Claims 18 to 23 is produced, said solution being composed of an alcohol ingredient and erythritol alone or in combination with xylitol.

29. A solution as a raw material from which the sherbet defined in any one of Claims 18 to 23 is produced, said solution being composed of an alcohol ingredient, erythritol alone or in combination with xylitol, and a saccharide other than erythritol and xylitol.

30. A solution as a raw material from which the sherbet defined in any one of Claims 18 to 23 is produced, said solution being composed of an alcohol ingredient, erythritol alone or in combination with xylitol, a saccharide other than erythritol and xylitol, and a thickening stabilizer.

31. A solution as a raw material from which the sherbet defined in any one of Claims 18 to 23 is produced, said solution being composed of an alcohol ingredient, erythritol alone or in combination with xylitol, and a thickening stabilizer

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP97/03738

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^6 A23G9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^6 A23G9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP, 59-102359, A (Otsuka Pharmaceutical Co., Ltd.), June 13, 1984 (13. 06. 84) & EP, 127686, A & WO, 8402256, A	1 2 - 31
Y	JP, 49-134874, A (Kanebo, Ltd.), December 25, 1974 (25. 12. 74) (Family: none)	2 - 17
Y	JP, 4-8252, A (Snow Brand Milk Products Co., Ltd., Fanshi Aisu K.K.), January 13, 1992 (13. 01. 92) (Family: none)	10, 13-15, 17-31
Y	JP, 5-260945, A (Nagatanien Co., Ltd.), October 12, 1993 (12. 10. 93) (Family: none)	10, 13-15, 17-31
Y	JP, 6-70689, A (Kanebo, Ltd.), March 15, 1994 (15. 03. 94) (Family: none)	2-17, 23-31
Y	JP, 7-132048, A (Nisshin Sugar Mfg. Co., Ltd.), May 23, 1995 (23. 05. 95) (Family: none)	2-5, 7-15, 23-31

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
November 6, 1997 (06. 11. 97)	November 18, 1997 (18. 11. 97)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/03738

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 61-100160, A (Best F K.K., Daiei shokuhin Kogyo K.K., Daiei Yakuhin Kogyo K.K., Shigeo Amano, Yoshio Toshigai), May 19, 1986 (19. 05. 86)(Family: none)	1 - 31
A	JP, 57-91156, A (Sato Shokuhin Kogyo K.K.), June 7, 1982 (07. 06. 82)(Family: none)	1 - 31
A	JP, 46-40193, B (Ezaki Gulico Co., Ltd.), November 27, 1971 (27. 11. 71)(Family: none)	1 - 31

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

PATENT SPECIFICATION

(11) 1 519 294

1 519 294

(21) Application Nos. 31266/74 and 31267/74
(22) Filed 15 July 1974
(21) Application No. 11161/75 (22) Filed 26 March 1974
(62) Divided out of No. 1 508 437
(23) Complete Specification filed 26 June 1975
(44) Complete Specification published 26 July 1978
(51) INT CL.[2] A23G 9/02
(52) Index at acceptance A2B 16
(72) Inventors DAVID JOHN FINNEY and IAN CUNNINGHAM MUTTER DEA

(19) THE PATENT OFFICE LONDON

(54) ICE CREAM

(71) We, UNILEVER LIMITED, a company organised under the laws of Great Britain, of Unilever House, Blackfriars, London, E.C.4, England, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to stabilised ice cream. The way in which ice cream behaves on exposure to normal room temperature is important for the consumer. If a product behaves too atypically, for instance if a product melts too rapidly or separates into a fatty phase and a clear aqueous phase on melting, then the product will be unacceptable. In the ice cream industry methods have been developed for measuring such properties, for instance melt-down and stand-up. These are described later.

It is known that such properties can be affected by the use of stabiliser, often called thickeners. A problem that arises is that the stabilisers deleteriously affect the feel of the ice cream in the mouth; a cloying, gummy or even greasy feel can occur. This problem is acute in ice creams that require more than usual stabilisation. What is desired is a stabiliser system that is good or at least adequate with respect to all aspects of stability. This is difficult to achieve for normal ice creams and particularly so for ice creams that require more than usual stabilisation.

A stabiliser system has now been found that is surprisingly effective in stabilising ice cream without giving an unacceptable mouth feel. The stabiliser system is agar-agar in combination with a galactomannan gum. Examples of galactomannan gums are guar gum, locust bean gum and tara gum. Locust bean gum or tara gum, particularly locust bean gum, is preferred.

The invention therefore provides ice cream stabilised with a stabiliser mixture comprising agar-agar and at least one galactomannan gum.

Chapter 6 of the standard text-book, Ice Cream, by Arbuckle, Second Edition, The Avi Publishing Company, 1972 contains a survey of possible stabilisers for use in ice cream. Two of these are agar-agar and locust bean gum (carob gum). On agar-agar Arbuckle states that it has been recommended for use in combination with gums for gelation in sherbets and ices but continues: "Although it swells and absorbs large quantities of water and thus prevents coarseness in the finished product, it is not easily dispersed in the mix and tends to produce a crumbly body. It is also high in cost." On locust bean gum Arbuckle states that it "is an ingredient of stabiliser sold mainly for use in sherbets and ices. Its principal advantage in these products is that it inhibits overrun. Since it has a tendency to cause curdling of the milk proteins, its use in ice cream is limited, and heating to temperatures above 100° F should be avoided." It has now surprisingly been found that these two stabilisers in combination are significantly better stabilisers than would be expected from the above or from study of each separately.

As emphasised above the stabiliser system is particularly useful in ice creams that require more than usual stabilisation.

Conventional ice cream is prepared by a process involving freezing and then hardening to temperatures in the order of −20° C to −40° C. The product characteristics required for a conventional ice cream will depend on the personal tastes of the consumer and ice creams are formulated to meet a variety of such tastes; the formulation of any one conventional ice cream will depend on the tastes of the consumers concerned.

One characteristic of ice cream that we have recognised to be important is the log C, as defined later, of the ice cream. In the UK from our measurements conventional ice creams have a log Cs at −20° C, after hardening at the lowest of 2.9 (and at the highest of 3.7) but usually in the range of 2.9 to 3.3. (A technique for measuring C and hence log C is described later in the specification.) C values will be taken after hardening conventionally as indicated and as for instance

described in the standard text-books.

It has been found that an ice cream spoonable at −20° C has major advantages over conventional ice cream in particular in that it is more readily spoonable at deep-freeze temperatures and so can be served more readily direct from the deep freeze. A correlation has been found to exist between spoonability and log C and it has been found that, for an ice cream to be spoonable, its log C at −20° C should be less than that of conventional ice cream, i.e. less than 2.9 and preferably less than 2.8, particularly preferably less than 2.5.

This invention, by which hardened ice cream with a log C at −20° C of less than 2.9 is provided is described and claimed in our copending application 13288/74 (Serial No. 1,508,437) (cognate of 13288/74, 30165/74 and 2978/75).

Conveniently such an ice cream can be achieved by addition of freezing-point depressants to the formulation of a conventional ice cream, at the expense of water, in amounts sufficient to lower the log C at −20° C by between 0.25 and 1, preferably by 0.4 to 0.75. It should further be noted that the log C at −20° C of an ice cream according to the invention should preferably not be less than 2.3.

A particularly surprising aspect of the invention is the achievement, by use of the claimed stabilizer mixture, of an ice cream formulated to have a log C at −20 C of less than 2.9 but with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at −20 C is between 0.25 and 1 higher, preferably 0.4 to 0.75 higher, than that of the ice cream formulated to have a log C at −20C of less than 2.9.

In general more freezing-point depressants will be used than in conventional ice creams. Preferred freezing-point depressants are monosaccharides and low molecular-weight alcohols (i.e. molecular weights less than 100), preferably polyalcohols and in particular glycerol and sorbitol. The freezing-point depressant or depressants should preferably be such that the product has the desired (by the consumer) sweetness as well as the desired spoonability at −20° C.

Such ice creams are examples of ice creams that benefit from careful stabilisation. Our copending application referred to mentions and claims the stabilisation with locust bean gum, particularly with other stabilisers. A particularly important aspect of the present invention is the use of a stabiliser mixture comprising agar-agar and at least one galactomannan gum to stabilize such ice creams.

Galactomannan gums and agar-agar are well-known materials and are described for instance by M Glicksman in "Gum Technology in the Food Industry", Academic Press, 1969.

The amount of agar-agar should, in an ice cream, preferably be from 0.05% to 0.15% by weight; the amount of galactomannan gum should preferably be from 0.05% to 0.20% and the weight ratio of agar-agar to galactomannan gum should preferably be in the range 1:1 to 1:3. The amounts and ratio of the two stabilisers depends to some extent on other ingredients present but the above is a useful general rule and in any case can be determined readily by experiment.

Of course preferably neither component should be at or near its lower limit in any one stabiliser system. The total amount of these stabilisers is preferably 0.15% or above.

The stabiliser system, preferably also contains a maltodextrin of DE (dextrose equivalent) less than 20, preferably less than 15. The maltodextrin must be soluble. The lower limit for DE at which maltodextrins become insoluble depends particularly on the other ingredients in an ice cream mix but whether a given maltodextrin is soluble in any such mix can be determined readily by experiment and in particular by noting whether it leads to the desired effect.

It is believed that the maltodextrin excludes water from protein, such as casein, present in ice cream and causes the protein to precipitate, particularly on heating, for example, during pasteurisation. The precipitated protein destabilises the fat droplets in the ice cream by causing them to clump and finally to coalesce which affects the stability of the ice cream. The amount of low DE maltodextrin should preferably be in the range 0.5—3%.

Maltodextrins can for example be obtained by the mild hydrolysis of starch. Enzymatic hydrolysis, optionally under acidic conditions, of the starch can be used; the conditions are so mild that negligible repolymerisation occurs. This is in contrast to dextrins which typically are made from starch by hydrolysis and repolymerisation using high temperature and pressure.

In this specification, including the claims, percentages are by weight and in particular are by weight of ice cream except where the context requires otherwise.

Other than in the use of sufficient freezing point depressant for the preferred aspect of the invention and in the use of a stabilising system comprising particular components no especial insight is required in the formulation or processing of ice creams according to the invention. Details of conventional formulations and processing conditions for ice cream can be found in the usual trade publications and text books. Particularly useful in this respect is Arbuckle, "Ice Cream", 1972 (2nd Edition), AVI Publishing Corp., Westpoint, Conn.

The invention will now be illustrated further by the following examples.

The properties of the stabiliser system are most surprising when compared with the properties of the separate components. This is illustrated in the examples.

EXAMPLE 1.

An ice cream was prepared by conventional processing techniques to the following formulation:

Ingredient	% by weight
Skimmed Milk Powder	12.0
Sugar	10.0
Sorbitol	3.0
Dextrose (monohydrate)	3.0
Butter	12.0
Mono/Di-glyceride emulsifier	0.3
Agar-agar 434*	0.1
Locust Bean Gum	0.15
17 DE Maltodextrin	2.0
Water	to 100.0

* Sold by Thomas Douche Ltd., London and found to have a positive contribution, as discussed above, of 8°.

An ice cream was obtained that was spoonable at domestic deep freeze temperature and yet had excellent stand-up, melt-down, taste and texture at normal eating temperature.

EXAMPLES 2 to 7
and COMPARISONS A to D

Ice cream mixes were prepared conventionally to the following formulation. Further details are given in the following Table which also shows results obtained with ice cream prepared conventionally from the mixtures. A standard UK non-dairy ice cream differs from this formulation in containing no glycerol and 1.4% by weight more sugar. 3% glycerol is roughly equivalent in sweetness to 1.5% sugar.

Spray dried milk powder	9.5
Sugar	13.5
Glucose syrup	1.7
Palm oil	9.5
Monoglyceride from palm oil	0.5
Glycerol	3.0
Salt	0.05
Flavour and colour	0.1
Stabilisers	Table
Water	to 100

The log C values at −20°C of the Examples were in the range 2.5 and 2.9. The log C of the standard ice cream mentioned above was in the range 3.2 to 3.3.

Example or Comparison	Stabiliser % by weight			Min Viscosity (cps)	Overrun %	Meltdown at 15°C		Shape Retention	Stability Cycling
	LBG	Agar-Agar	Low-DE Maltodextrin			1st 10 ml (mins)	Rate (mls/hr)		
A		0.1		42	64	100	28	Poor	Poor
B	0.175			44	85	80	26	Poor	Poor
C			2(17–DE)	17	52	50	136	Bad	Bad
D	0.175		2(17–DE)	58	110	110	13	Fair	Poor
1	0.175	0.1	2(17–DE)	79	115	126	8	Good	Fair
2	0.175	0.1	2(17–DE)	79	115	126	9	Good	
3	0.175	0.05	2(17–DE)	49	121	125	9	Fair	Fair
4	0.1	0.1	2(17–DE)	44	123	115	9	Fair.	Fair
5	0.175	0.1	1(17–DE)	66	118	127	7	Good	
6	0.175	0.1	2(12–DE)	57	118	135	9	Fair	Good
7	0.175	0.15	2(17–DE)	59	105	140	8	Good	Fair

* The agar-agar is a normal agar-agar, e.g. one from a Gelidium seaweed.

Test Methods

Melt-Down Test and Shape Retention

A rectangular block of ice cream of length 13.6 cm, height 4.0 cm and width about 8.8 cm which has been stored at −20° C is placed on a wire gauze (10 wires per inch) in an atmosphere maintained at 15° C. Arrangments are made for collection of the liquid drained from the gauze. The time for the collection of the first 10 ml of liquid is noted. The volume of liquid collected in each subsequent 10 minute period is measured and the slope of the graph obtained by plotting volume collected against time is taken as the meltdown (mls/hr). After 4 hours thawing photographs of the residue of the brick are taken, and the degree of shape retention assessed as bad, poor, fair, good or very good.

Stability to Temperature Cycling

This was carried out on an approximately cuboid ½ gallon block of ice cream in a plastic container. After storage in a deep-freez it was transferred to ambient (20° C) for 1½ hours and then to a refrigerator at −10° C. Next day the block was subjected to further temperature shock cycling by being taken out of the refrigerator and left at ambient for ½ hour. This (each day ½ hour at ambient) was repeated to a total of six times and then the block was returned to the deep-freeze for assessment the next day. The total test took, allowing for a weekend, not more than ten days. Product stability was assessed as follows:

Bad: total breakdown
Poor: >20% of product converted to serum
Fair: 5—20% of product converted to serum
Good: <5% of product converted to serum

C and Log C

To determine C and hence log C the following method is used:

Principle

The hardness of ice cream is measured by allowing a standard cone to penetrate a sample for 15 seconds using a cone penetrometer. The C-value can be calculated from the penetration depth.

Apparatus:

Ebonite cone

With an apex angle of 40° and the tip blunted by a few strokes on fine abrasive paper to give a flat 0.3 ± 0.03 mm in diameter. Total weight of cone and sliding penetrometer shaft 80 ±0.3 g.; also additional weights of 80 ±0.3 g.

Penetrometer

This should have a scale calibrated in 0.1 mm., and be fitted with a lens. The penetrometer made by Sommer and Runge, Berlin, is recommended, particularly for static use. The Hutchinson instrument can also be used; it requires no electricity supply, but must be modified for satisfactory operation. The accuracy of penetrometer timing mechanisms must be checked regularly. The use of a ×3 magnification lens of about 6—8 cm. diameter fitted to the penetrometer facilitates the setting of the cone tip on the sample surface, and an unfocused light limited to the equivalent of a 1-watt bulb at a distance of about 5 cm. (to avoid heating the sample surface) is also advantageous.

Temperature probe

The temperature probe should read to within 0.1° C and have a stem about 1 mm. in diameter and about 4 cm. long. Its accuracy should be checked regularly in baths of known temperatures.

Tempering facilities

(a) Room controlled at required temperature ± 1° C;
(b) Constant-temperature cabinets, tolerance ±0.2° C.

The forced-draught constant-temperature cabinets supplied by Zero N.V. Rotterdam are satisfactory.

Process:

Sampling

Samples should be convenient size and preferably with smooth surfaces to increase accuracy.

Tempering

2 Days at whatever temperature is required e.g. −20° C. Measure temperature accurately before penetration.

Measurement

Where possible, penetrations are made in the temperature-controlled room, and should be completed within two minutes of removing the sample from the constant-temperature cabinet.

1. Insert the temperature probe as near horizontally as possible at a few mm. below the sample surface, read and note the sample temperature after 30 seconds. (Reject any samples differing by more than 0.5° C from the nominal test temperature.)
2. Place the samples on the levelled penetrometer table.
3. Set the cone tip accurately on the sample surface, using a lens and, if necessary, oblique lighting.
4. Release the arresting device and allow the cone to penetrate the sample for 15 seconds.
5. Read and note the penetration depth.
6. Should the penetration depth be less than 72 × 0.1 mm. (equivalent to a C-value of more than 500g./cm.^{2}) the measurement should be repeated with the cone weight increased by 80 g. Further 80 g. weights may be added as necessary to ensure adequate penetration of the sample and the C-value scale reading corrected accordingly.
7. Penetration measurements should not be made within 2 cm. of the sample edge nor within 2.5 cm. of each other. Determinations in which air bubbles, cracks, etc. interfere should be rejected.

Calculation of C-values

The C-value can be calculated from the penetration depth using the formula:

$$C = \frac{K \times F}{p^{1.6}}$$

where

C = Yield value or C-value (g./cm.²)
F = Total weight of cone and sliding stem (g.)*
P = Penetration depth (0.1 mm.)
K = Factor depending on cone angle:

Cone angle°	K value
30	9670
40	5840
60	2815
90	1040

* Depending on the likely softness of the product, the cone weight should be adjusted, eg

at −10° C	use 80 gm
at −15° C	use 160 gm
at −20° C	use 240 gm

ie it depends on temperature of measurement.

C values will usually be taken after hardening conventionally, as for instance described on page 4, lines 18 to 20, and in the standard text-books.

It should be noted that an ice cream based on vegetable fat according to the invention preferably has a melt-down, determined as described above, of less than 25 ml/hr and particularly preferably of between 5 and 20 ml/hr.

WHAT WE CLAIM IS:—

1. Ice cream stabilised with a stabiliser mixture comprising agar-agar and at least one galactomannan gum.

2. Ice cream as claimed in Claim 1 in which the amount of agar-agar is at least 0.05% by weight of the ice cream.

3. Ice cream as claimed in Claim 2 in which the amount is not more than 0.15%.

4. Ice cream as claimed in any one preceding claim in which the amount of galactomannan gum or gums is at least 0.05% by weight of the ice cream.

5. Ice cream as claimed in Claim 4 in which the amount of galactomannan gum or gums is not more than 0.2% by weight of the ice cream.

6. Ice cream as claimed in any one preceding claim in which the total amount of agar-agar and galactomannan gum or gums is at least 0.15% by weight of the ice cream.

7. Ice cream as claimed in any one preceding claim characterised in that the weight ratio of agar-agar to galactomannan gum or gums is in the range 1:1 to 1:3.

8. Ice cream as claimed in any one preceding claim which has a log C as herein defined of less than 2.9 at −20° C.

9. Ice cream as claimed in Claim 8 which has a log C less than 2.8 at −20° C.

10. Ice cream as claimed in Claim 9 which has a log C less than 2.5 at −20° C.

11. Ice cream as claimed in any one of Claims 8 to 10 which has a log C at −20° C as herein defined of not below 2.3.

12. Ice cream as claimed in any one of Claims 8 to 11 with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at −20° C is between 0.25 and 1 higher.

13. Ice cream as claimed in Claim 12 with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at −20° C is between 0.4 to 0.75 higher.

14. Ice cream as claimed in any one preceding claim containing glycerol or sorbitol as a freezing-point depressant.

15. Ice cream as claimed in any one preceding claim based on vegetable fat and with a melt-down as herein defined of less than 25 ml/hr at 15° C.

16. Ice cream as claimed in Claim 15 in which the melt-down is between 5 and 20 ml/hr at 15° C.

17. Ice cream as claimed in any one preceding claim in which the galactomannan gum is locust bean gum or tara gum.

18. Ice cream as claimed in Claim 18 in which the galactomannan gum is locust bean gum.

19. An ice cream as claimed in Claim 8 substantially as described and with particular reference to Example 1.

20. Ice cream as claimed in Claim 8 substantially as described and with particular reference to any one of Examples 2 to 7.

J M REID,
Agent for the Applicants

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.